APPLIED
Hydraulics & Pneumatics

SYSTEMS • COMPONENTS • SERVOS • ELECTRIC CONTROLS • SEPTEMBER 1959

Missiles & GSE

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THE MAGAZINE OF FLUID POWER

PUBLISHED BY THE INDUSTRIAL PUBLISHING CORPORATION

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CONNECTION
or
DISCONNECTION

with
INSTANT
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or
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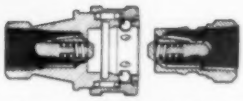

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- FOUR FLEXIBLE SEALING SURFACES
- LOW FRICTION INSTALLATION
- HIGH DENSITY INJECTION MOLDED
- RUBBER COMPOUNDS TO FIT APPLICATION

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APPLIED
Hydraulics & Pneumatics

VOLUME 12/NUMBER 9

SEPTEMBER 1959 THE MAGAZINE OF FLUID POWER

MISSILE HYDRAULICS AND PNEUMATICS

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BPA VAC

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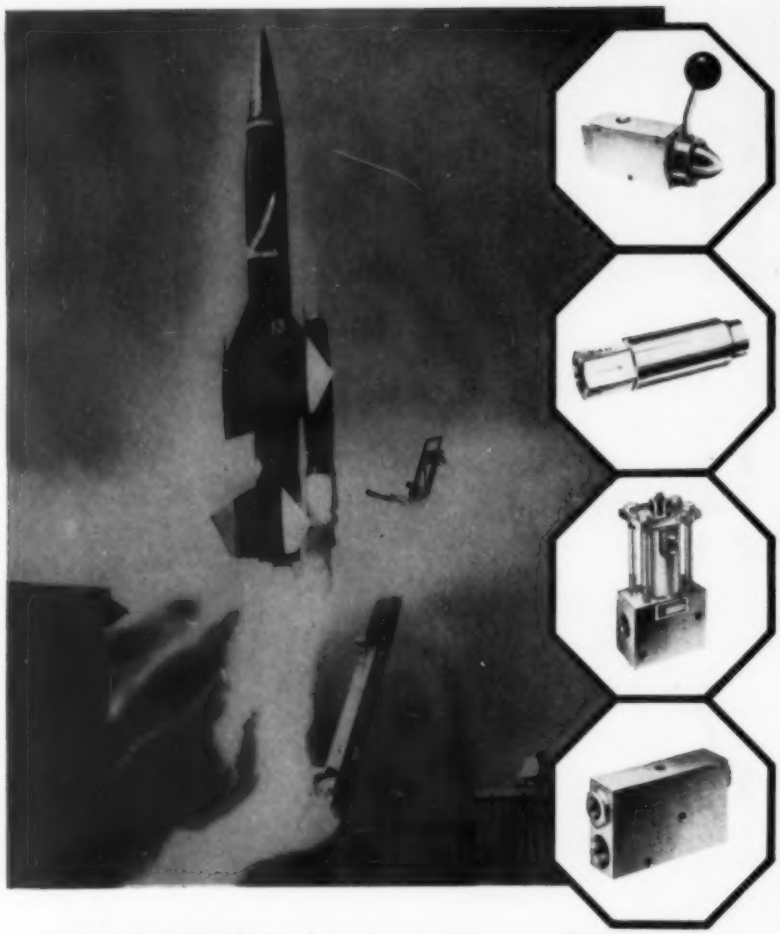

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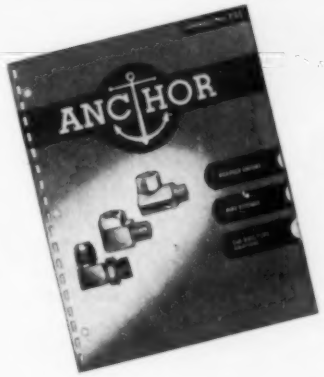
USEFUL LITERATURE

NEW ANCHOR CATALOG DESCRIBES ANCHOR'S EXPANDED LINE OF HYDRAULIC FITTINGS, UNIONS and ADAPTERS



This recently issued catalog is a revision of an earlier catalog describing Anchor's line of hydraulic fittings, unions and adapters, and now includes many new sizes and a general expansion of the line. It contains complete specifications, illustrations and drawings, including full information about the new items, plus other data and engineering information that will prove helpful to the engineer in designing fluid power transmission systems.

The Anchor line of Adapter Unions, Tees and Crosses is designed for use with Anchor Pressed-On or Reusable Coupling Hose Assemblies. They form a ground joint, leak-proof connection and eliminate one or more pipe thread joints at each connection. Assembly is made easier, especially in confined areas. Straining and twisting of hose in assembly is eliminated.

Positive leak-proof seating, without danger of thread distortion or damage, is provided when Anchor SAE Straight Thread "O" Ring Boss Type Fittings are used. Straight, 45° and 90° adjustable elbows, a tee, service tee and a 90° check valve are available to provide a maximum degree of flexibility in making boss connections. Connections can be loosened and retightened any number of times without danger of leaks.

Several styles of Anchor Tube Nuts for tube diameters from ⅛" to 2" are illustrated.

Copies of the new Catalog No. 205 may be obtained by writing Anchor Coupling Co. Inc., 336 No. Fourth St., Libertyville, Illinois.

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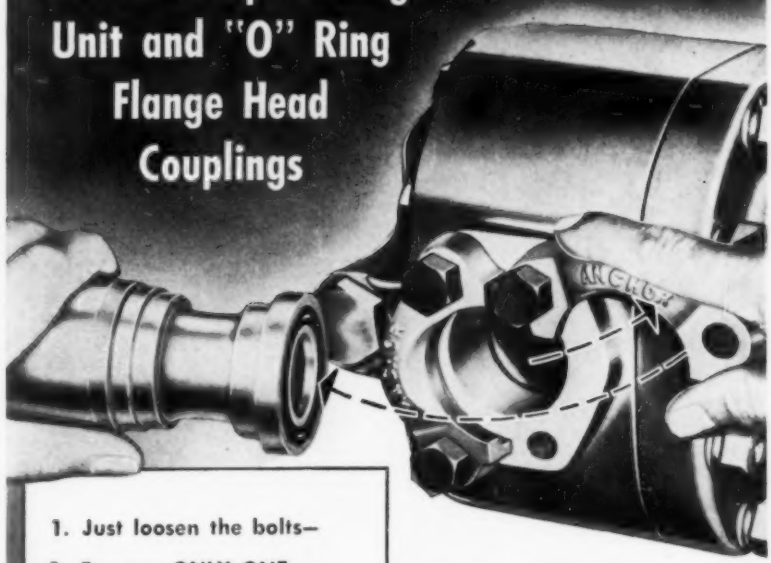
Easier to Connect or Disconnect!

ANCHOR FLANCO®

SAE 4-Bolt Split-Flange Unit and "O" Ring Flange Head Couplings



1. Just loosen the bolts—
2. Remove ONLY ONE—
3. Pivot the Split-Flange Clamp Half, together with the "O" Ring Flange Head Coupling, around the other bolt—
4. Remove Hose Coupling!

To reconnect, just reverse the procedure.

Try connecting and reconnecting a FLANCO Coupling in close quarters to fully appreciate the convenience of this patented Split-Flange Clamp design!

In addition, with FLANCO couplings you can reduce production costs by eliminating costly pipe threading operations—use more easily handled, small, automotive type wrenches to make up joints—and you eliminate separate union and swivel connections. Hose lines can be disconnected and reconnected many times without leaks, because there are no threads to wear out or tapered seats to groove with FLANCO Split-Flange Halves and "O" Ring Flange Head Couplings.

FLANCO "O" Ring Flange Head Type Couplings are available in Pressed-On, or Reusable Clamp Type, as well as Weld Type Fittings.

Andy Anchor says:

You can get the complete story on FLANCO Split-Flange Halves and "O" Ring Flange Head Type Couplings by writing for Catalog 402.

ANCHOR COUPLING CO. INC.

335 No. Fourth Street — Libertyville, Ill.
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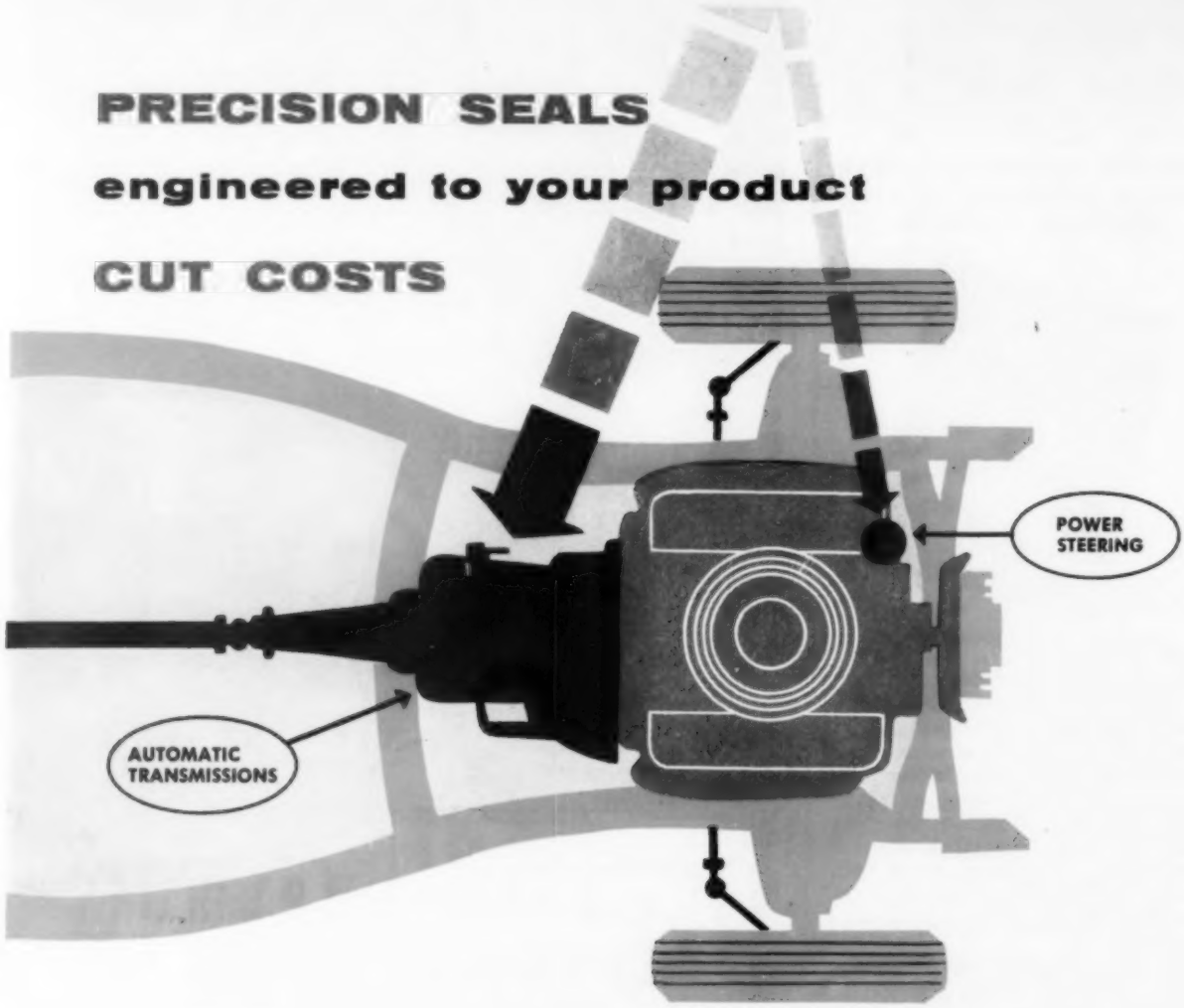
engineered to your product
CUT COSTS



Problem Solving is a common occurrence at Precision. One was the development of a universal compound for automatic transmissions and power steering systems. **The Solution** – Precision Compound No. 6767 – provided an "O" Ring with these characteristics. Suitable for all transmission fluids... long life over a temperature range of – 40F to 300F... excellent resistance to cracking... low volume change – particularly type "A"... low compression set... high modulus. Precision creative research has reduced costs by producing the right "O" Ring for many manufacturers. You can benefit too, for the services of a Precision engineer are available to help you obtain the right product design and the right "O" Ring for it. Write or phone for his services today.

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"O" Ring and Dyna-seal Specialists

Dept. 1, Oakridge Drive, Dayton 7, Ohio **Canadian plant at: Ste. Thérèse de Blainville, Québec**

. . . Fluid Power news

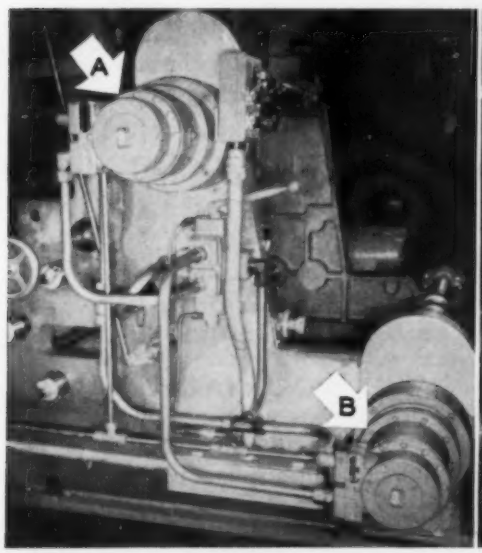
REPORT No. 12,300 HIGH PERFORMANCE WINDER DRIVES

From Oilgear Application-Engineering Files

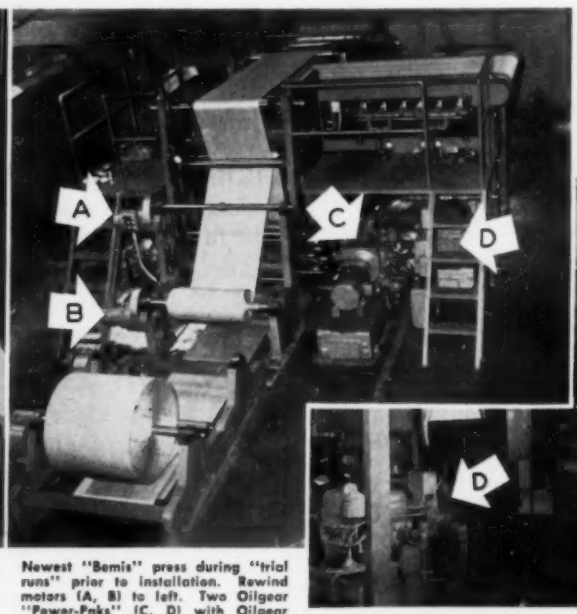
HOW OILGEAR PROGRESSIVE ENGINEERING PACES IMPROVEMENTS ON "BEMIS" MACHINES

CUSTOMER: *Bemis Bro. Bag Company, St. Louis, Missouri*

DATA: To efficiently produce the wide scope of paper, cloth, and polyethylene "Flexible Packaging" for which they are famous, "Bemis" designs and builds their own production machinery. Basically, "Bemis" machines are roll-fed, multi-color printing presses capable of very close register . . . operating from inching speeds of 15 fpm to running speeds of 400 to 1000 fpm. Press runs range from 1000 to 1,000,000 bags. Being roll-fed presses, winder drives and controls were a major problem, as ratios of 5:1 up to 10:1 from core to finished roll diameter are not uncommon. Paper widths vary from 10″ to 56″, with roll weights from 1000 to 2000 lb. "Bemis" specified that their winder drives must be compact; easy for shop, maintenance, and operator personnel to adjust, maintain, and understand. All electrical controls must be simple, with standard components preferred. Each machine to have one main control panel, and three or four remote, push-button panels — with some constant indication of load and tension as a desirable feature. Long, trouble and maintenance-free life was also of prime importance along with ease in installation.



Close-up of face-mounted, Oilgear Type "H" Fluid Power Motors (A, B), geared to rewind spindles of newest "Bemis" machine, shown center. Oilgear Type "D" Pump on "Power-Pak" (C) — center photo — supplies Fluid Power for rewind drive.



Newest "Bemis" press during "trial runs" prior to installation. Rewind motors (A, B) to left. Two Oilgear "Power-Paks" (C, D) with Oilgear Type "D" Pumps and Controls can be seen "tucked away" under the dryer section.

View "around-back" of new "Bemis" press dryer section, showing Oilgear Type "D" Pump and Controls on "Power-Pak" (D) which supplies Fluid Power to Oilgear Type "H" Motor (E) for main press drive. See "Note" below on Oilgear Pump (F), direct-coupled to tail-shaft of Motor (E).

SOLUTION: Through a program of constant improvement and engineering teamwork, Oilgear *Fluid Power* Drive and Control Systems have so successfully paced requirements for more efficient production equipment that "Bemis" plants in 16 cities now have 48 machines equipped with Oilgear winder drives. Dancer roll controls are used on 39 . . . 9 more recent installations have "*HYTAC SYSTEM" drives. Two newest machines (one shown above) have Oilgear Type "D" electrohydraulic servo controlled main press drives, and hydraulic servo controlled winder drives. One reason for this ever-increasing use of Oilgear "Any-Speed" drives has been clearly stated as follows: *"We put them in and forget about them . . . some have been operating for over 11 years without service or repair — many loaded to maximum capacity — others have had no oil change in five years"* . . . proof of the statement heard in all industry — *"For the lowest cost per year — it's Oilgear!"* One "Bemis" installation using a HYTAC SYSTEM winder drive handles 40 to 70-lb kraft stock 26″ to 63″ wide. This winder operates over a 13:1 ratio — from 3¼″ diam. cores to 43½″ diam. rolls — is limited only by interference on the machine. Of this HYTAC SYSTEM, "Bemis" states — *"Other types of variable speed drives could never do this . . . operating beyond our fondest hopes."*

*HYTAC SYSTEMS — An Oilgear Trademark

NOTE: *An unusual installation feature is partially visible on photo above. Oilgear Type "H" Fluid Power main press drive motor (E) is also direct-coupled to Oilgear Type "H" Pump (F) which supplies Fluid Power to an Oilgear Type "H" Motor — not shown — that drives the dryer fan.*

USER REPORTS — *" . . . exceptionally fine acceleration control . . . smooth creeping and inching speed up to maximum . . . exceptionally smooth running speed . . . are easier to adjust than other drives . . . require less space . . . pressure gage shows load while drive is in operation . . . maintain an adjustable tension from constant tension to constant torque."* "Bemis" — like other users — has found that Oilgear Drive and Control Systems give them constant tension, automatic tapering tension, stall tension, constant torque, automatic tapering torque, or a combination of tension and torque characteristics to meet their every production requirement.

For practical solutions to YOUR linear or rotary Controlled-Motion problem, call the factory-trained Oilgear Application-Engineer in your vicinity. Or write, stating your specific requirements, directly to . . .

THE OILGEAR COMPANY

Application-Engineered Controlled Motion Systems

1564 WEST PIERCE STREET • MILWAUKEE 4, WISCONSIN

FLUID POWER LINES

about hydraulics & pneumatics

5 . . . 4 . . . 3 . . . 2 . . . 1 . . . LIFTOFF! . . . The earth has completed one full orbit around the sun since our last missile issue. During that time, some additional hardware was thrown into solar orbit, animals have taken space rides, and a flock of new missiles were added to the roster. In keeping with these trends, AH&P's missile issue is a shade farther out in space this year. Fluid power, once a fairly earthly matter, is destined for other planets. Whether it's for engine gimballing, steering jets, or solar mirror erection, fluid power systems will tackle the job. Components and fluids may become exotic, and space jargon may clutter our plumbing vocabulary, but "servo actuators" still push and pull, and "bootstrap" reservoirs are still tanks.

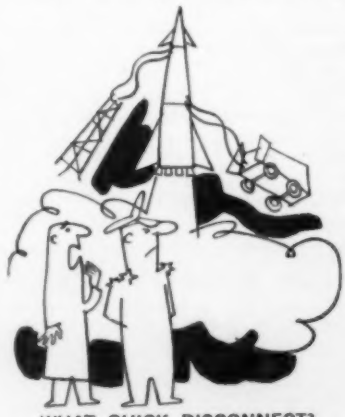
Four members of our Aviation Advisory Board take a forward look into needs in systems and components.

Missiles with their GSE have been reduced to fluid power essentials for this issue. Although missile environments are extreme, ground support systems seem to be a marriage of aircraft and industrial concepts; they are not strapped by flight weight and bulk restrictions.

FIRE WHEN READY, GRIDLEY! . . . In all the annals of science fiction—past or present—the only author who took the trouble to even mention ground support equipment, was Jules Verne. He visualized a lunar vehicle as a high projectile shot from a mammoth cannon. This was truly GSE! Even Verne missed the boat though, because he neglected to account for muscular ground handling tasks. Missile systems originate in the aircraft industry, but the hydraulics of transporting, erecting and launching these "birds" is a job for industrial fluid power.

MISSILE MUSCLES RUN HOT AND COLD . . . From sizzling rocket exhaust to liquid hydrogen, fluid power must function accurately and reliably. Let's not even mention the coming hurdles of space, such as solar and interstellar temperature and radiation. So far, fluid power has kept stride with the rocketeers.

WANTED . . . APU. . . . MUST WORK HARD . . . Time was, when an airplane APU was a lawn mower engine driving a pump. You can't hardly do that no more. Using almost as much horsepower as an airplane engine, missile secondary power for hot gas generation or high pressure oil is quite a chunk of the total machine. Articles in this issue will give some idea of the enormous job in store for the auxiliary power unit. Too bad that most of these fine systems are designed to make oneway trips.

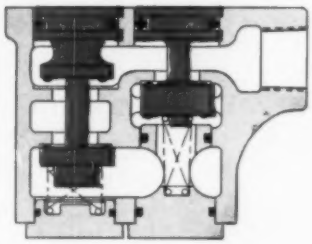


WHAT QUICK DISCONNECT?

WE WERE SWAMPED . . . when the results of our search for missile material poured in. Time and variety decided which one we used. Missile and GSE articles will appear in the coming months. Our thanks to those in industry and the armed forces who made this absorbing information available.

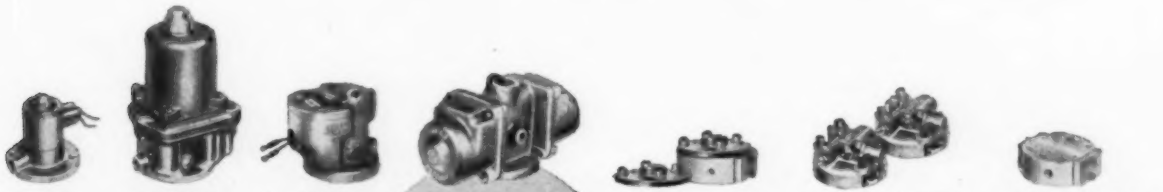
a basic Ross
valve building block

4-way inline mounted valve body



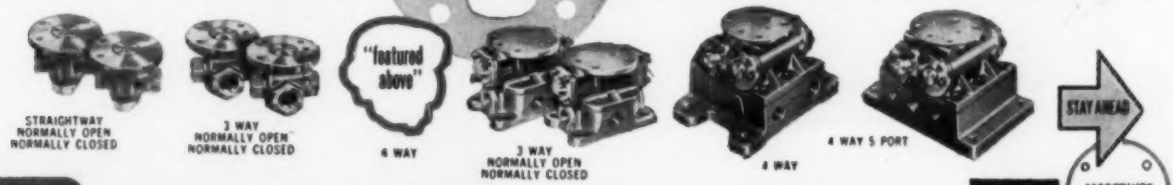
- **Compact—saves space**
- **Ross quality**
- **Costs much less than base mounted 4-way**

Lots of designers use this valve where they must save space. It was designed specifically for compactness! Others use it to save money *without sacrificing* quality—when J.I.C. allows the usage of an inline valve, it meets J.I.C. specs. It's a unit of the Ross Skyline series which features modular construction, so it can be actuated with any Skyline series head. Ross poppet construction means pressure assists the seal, and short poppet travel gives faster response. On most applications it outlives the machine—and frequently doesn't even require maintenance. Write for Bulletin 321.


* WHITEMODEL SPOOL SOLENOID
* GOLDMODEL OIL-IMMERSED SOLENOID
* SILVERMODEL JIC SPOOL SOLENOID
GREENMODEL DOUBLE SOLENOID MOMENTARY
BLUEMODEL AIR OPERATED
BLUEMODEL AIR-OPERATED MOMENTARY ADAPTOR
BLUEMODEL AIR-OPERATED TIMED IN
BLUEMODEL AIR-OPERATED TIMED-OUT
*THIS AIR INDEX ADAPTOR CONVERTS THESE HEADS TO MOMENTARY ACTION

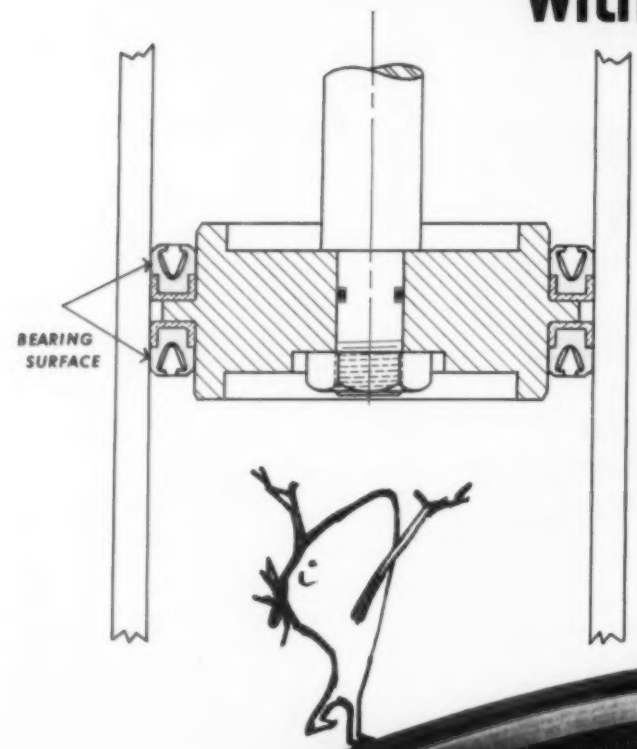
"every head meets every body at this gasket"

ALL SKYLINE HEADS AND BODIES ARE BUILDING BLOCKS TO GIVE YOU MANY VALVES FROM A FEW HEADS AND BODIES



ROSS OPERATING VALVE COMPANY
105 EAST GOLDEN GATE AVE. • DETROIT 3, MICH.

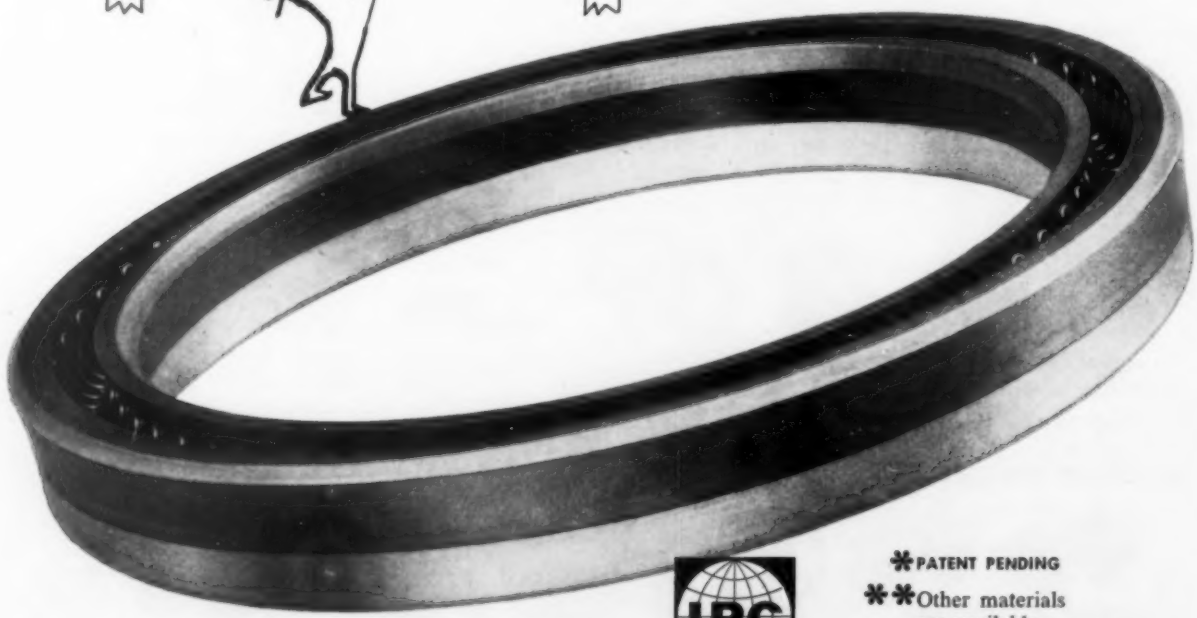
Squeeze down on expensive U-Packing Assemblies . . . with IPC's revolutionary "GUIDE-U-PAK"*. . . the packing with a built-in bearing!



A new engineering concept for hydraulic systems sealing! . . . IPC's GUIDE-U-PAK is a bonded case U packing that really puts the squeeze on expensive, complex U packing assemblies. Follower plates or back up plates with their high cost drilling, machining and fitting are eliminated. *Moreover,* GUIDE-U-PAK supplies its own bearing . . . riding smoothly on a close tolerance brass**case. You can end the practice of machining a wear sleeve on the piston surface, too! GUIDE-U-PAK is press fitted on the piston.

The "custom approach" in packings and seal manufacture, which typifies all IPC products, has brought this development through extensive testing. Precise manufacture means that you can specify critical tolerances for both ID and OD measurements or we will be glad to analyze your problem . . . recommend specific sizes. By establishing these limitations you can be assured of exact bearing surface and press fit.

For your next hydraulic sealing problem investigate GUIDE-U-PAK. You'll be pleasantly surprised!



OIL SEALS / PACKINGS / PRECISION MOLDING
Custom designed for your application . . .

IPC

*PATENT PENDING
**Other materials are available. Write for details.

INTERNATIONAL PACKINGS CORPORATION

Bristol, New Hampshire

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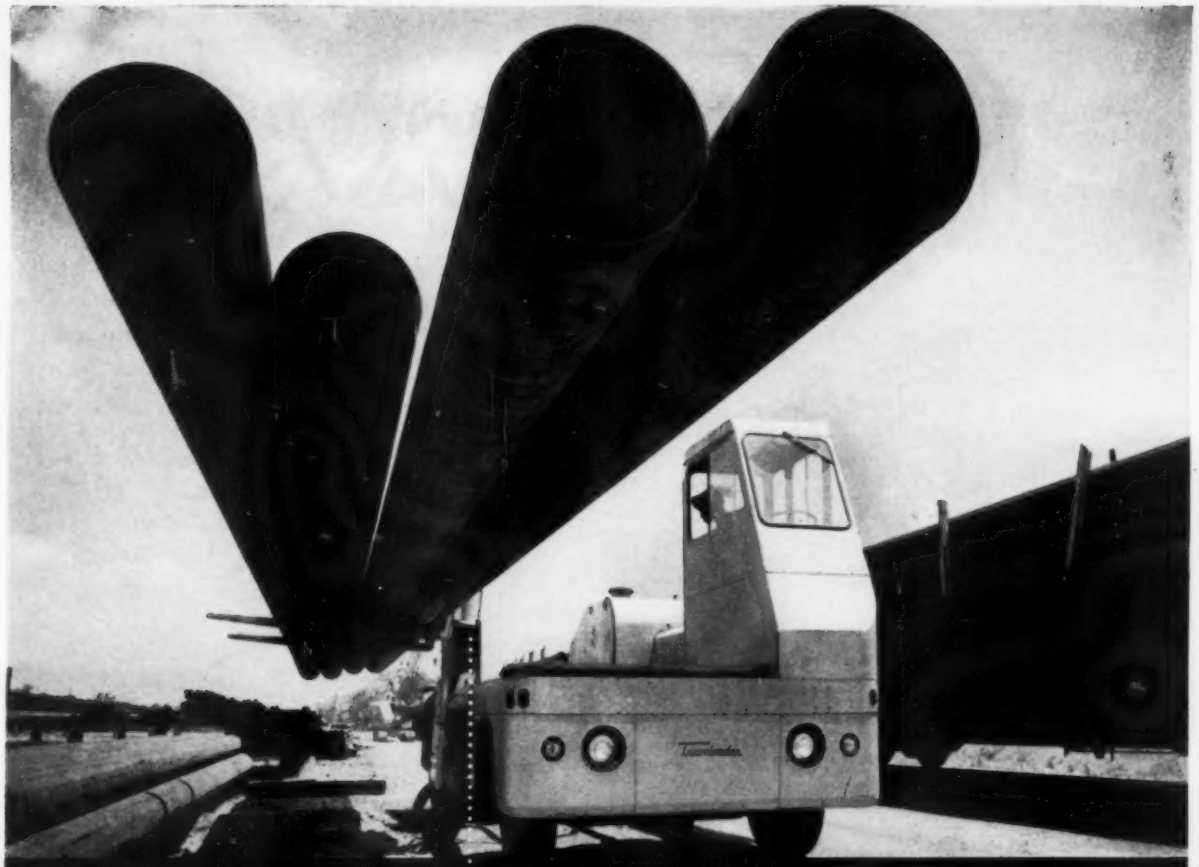
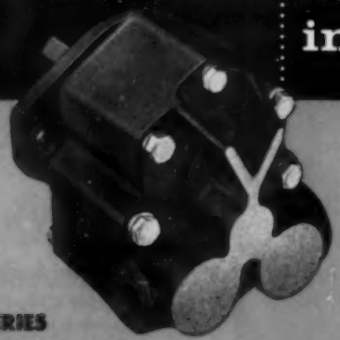
P-6



DYNAMIC DIFFERENCE

in hydraulic performance



"HC" SERIES

POSITIVE DISPLACEMENT GEAR-TYPE PUMP

Shaft seal: lip type
Drive: direct, gear or belt
Capacity: 5 sizes, 5 - 17 gpm
Pressures: to 1500 psi
Operating speeds: to 2400 rpm
Porting: side (Std.) end (Opt.)
Valve: Optional; internal relief, adjustable 800 - 1500 psi

BULLETIN HY11 gives complete engineering characteristics — performance and installation data.

Call the man from Webster

. . . he's one of a staff of engineers, specially trained in hydraulic application. He can help you solve special problems when hydraulics become a part of your design!

photo: Baker Industrial Trucks, div. of Otis Elevator Co., Cleveland, O.

Webster

POSITIVE DISPLACEMENT GEAR-TYPE PUMPS

Yesterday's pipe dream is today's nimble-fingered reality. This versatile fork lift truck unloads and stacks — carries a full platform load. The heart of its powerful hydraulic system is a Webster Gear-Type Pump. Just another example of Webster's practical and economical adaptation to hundreds of hydraulic applications . . . in lift systems, pressure lubricating, oil circulating . . . in industrial, agricultural and construction equipment.

Webster Gear-Type Pumps present many advantages in design "fit" and application — with unusual standardization and interchangeability of components. Keep Webster in mind when you plan hydraulics — for the dynamic difference that pays!

OIL HYDRAULICS DIVISION

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You asked

Molded End Seals Reduce Cost

. . . eliminate costly machining. Special plastic impervious to all synthetic oils, mild acids, coolants, and water to 300° F.

One piece construction

No spare parts necessary. Positive protection against dirt, sludge, rust and abrasive particles causing pump failure.

Exclusive Radial Fin Design

Permits larger filter capacity in smaller area. Mesh screen supplied in 60 or 100 screen depending on efficiency desired and fluid viscosity.

for this new

DOLLINGER

SUMP FILTER

All new design — Two years ago Dollinger asked hydraulic equipment designers throughout the country what service conditions sump filters must meet, and what they should cost. As a result of that study, this new Dollinger Sump Filter was designed. It not only meets all your service requirements, but it is also lower in price than competitive filters! Already, leading hydraulic equipment manufacturers have standardized on this new filter for their products.

New low price — The drastically reduced cost of this Filter is the result of a new design which incorporates molded end seals. These end seals are made from a specially formulated plastic impervious to all synthetic oils at temperatures up to 300° F.

Eight standard sizes are available with capacities from 5 to 100 GPM.

Get complete facts now, write for New Sump Filter Catalog No. 330.
The Dollinger Corporation, 65 Centre Park, Rochester 3, N. Y.

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STAYNEW FILTERS

DOLLINGER

SPECIALIZING IN DRY TYPE FILTERS FOR OVER 35 YEARS

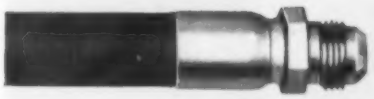
LIQUID FILTERS • PIPE LINE FILTERS • INTAKE FILTERS • HYDRAULIC FILTERS • ELECTROSTATIC FILTERS • MIST COLLECTORS • DRY PANEL FILTERS • SPECIAL DESIGN FILTERS • VISCOUS PANEL FILTERS • LOW PRESSURE FILTERS HIGH PRESSURE FILTERS • AUTOMATIC VENTILATION FILTERS • NATURAL GAS FILTERS • SILENCER FILTERS

Eastman first to be specified by America's leading OEM's...

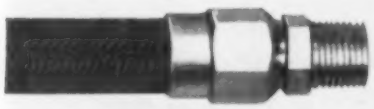
A COMPLETE LINE TO CHOOSE FROM FOR YOUR PARTICULAR APPLICATION

Available in all thread styles and sizes

Permanently Attached Male (NPTF) for 1, 2 and 3 Wire Braid rubber cover hose. Plated to prevent rust and corrosion.
Sizes: ¼" thru 2".
Wkg. Press.: 375—5000 p.s.i.

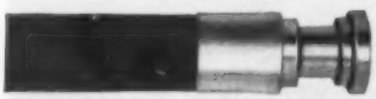


Permanently Attached Male Flare (JIC) for 4 and 6 Spiral Wire Braid rubber cover hose. Used for Ultra High Pressure.
Sizes: ½" thru 1½".
Wkg. Press.: up to 7500 p.s.i.

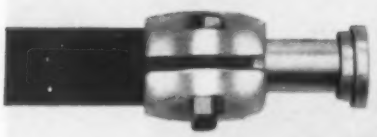


Reusable Male (NPTF) for cotton and rubber cover hose. No skiving necessary.
Sizes: ¼" thru 2".
Wkg. Press.: 350—3000 p.s.i.

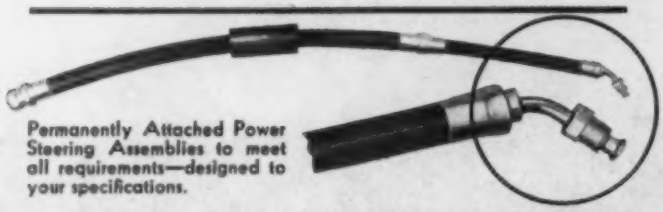
Reusable Swivel Female for 1 and 2 Wire Braid rubber cover hose. Easy field replacement.
Sizes: ¼" thru 1¼".
Wkg. Press.: 375—5000 p.s.i.



Permanently Attached Flange Head Couplings for 1 and 2 Wire Braid rubber cover hose. Available in angles to 90°.
Sizes: ½" thru 2".
Wkg. Press.: 375—5000 p.s.i.



Clamp Type Couplings with split flange stems for 1 and 2 Wire Braid rubber cover hose. Exclusive "Inter-Lock" feature.
Sizes: ½" thru 2".
Wkg. Press.: 375—5000 p.s.i.



Permanently Attached Power Steering Assemblies to meet all requirements—designed to your specifications.

Permanently Attached Air Conditioning Assemblies for automotive use—designed to your particular specifications.

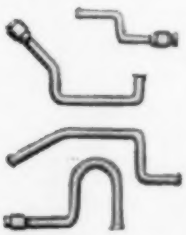
It's a known fact that many leading Original Equipment Manufacturers submit their original specifications for their *first* quotation to Eastman.

EASTMAN's unequalled experience in hydraulic conversion, plus many original designs shown in a few popular Eastman fittings at the left—give your product an appearance of quality that improves its competitive position. These assemblies are available in all thread styles and sizes.

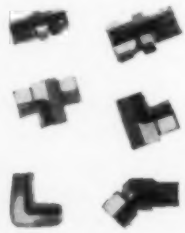
EASTMAN Engineering Service... Backed by Unequalled Experience

It is also a known fact that Eastman's co-operative engineering counsel and service is highly respected and often requested by leading OEM's. Let Eastman engineers help you lay out your fluid power lines—from pump to point of work—effecting economies in design, improving performance and increasing user satisfaction.

Let EASTMAN recommend the *best assembly . . . for the best performance . . . at the lowest cost.*



Bent Tubing with the necessary fittings to meet your own specific requirements.



Adapters, Adapter Unions and Boss "O" Ring Fittings. All types and sizes available.

FOR ADDITIONAL INFORMATION, WRITE EASTMAN MFG. CO., MANITOWOC, WISCONSIN OR PHONE: MURRAY 4-4495

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MANUFACTURING COMPANY
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See us at the SAE Engineering Show, Sept. 14-17, Milwaukee Auditorium—Booth A-3

LETTERS to the editor

Address your letters to: Editor, APPLIED HYDRAULICS & PNEUMATICS MAGAZINE, 812 Huron Rd., Cleveland 15, Ohio.

Needs hydraulic hose for 2000 psi

TO THE EDITORS:

We are interested in a hydraulic hose which will withstand 2000 psi working pressure and does not contain metallic reinforcement. Some of our portable equipment frequently becomes shorted across a low voltage, high amperage circuit. This causes damage to hydraulic cylinders. We're able to insulate the cylinder from its mounting brackets but the current transmitted by the wire braid in the hose still causes cylinder damage. An alternate solution would be to use insulated couplings in the hose line, but we've been unable to find any couplings rated for 2000 psi.

WILLIAM R. CLARK
Project Engineer
Reynolds Metal Co.
Richmond, Va.

There isn't a good source of supply for a 2000 psi hose which is not reinforced with metal. One company told us they have a Fortisan Braided Hose, which withstands these pressures and eliminates the problem of damage from electrical sources. This hose is only available with a 3/8" i.d. Even if this hose would do your job, it has to be ordered in quantities of at least 1500 ft. A 90-day delivery is the best that could be expected. Some users have tried insulating the assembly by putting a fibre disc between the end of the hose and the coupling. However, this doesn't work well on most assemblies because the coupling wraps around the metallic reinforcement.

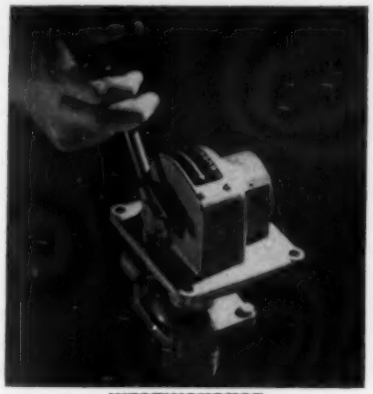
Wants copy of Heiser Book

TO THE EDITOR:

I would appreciate receiving a copy of "Air and Oil Cylinders" by Elmer Heiser. Since this book is no longer in stock, I am willing to climb a flagpole to secure one,

Continued on page 18

Typical Control Functions solved by AIR CIRCUITRY



WESTINGHOUSE "H" CONTROLAIR® VALVES

Air control valves are not limited to directional control in Westinghouse Air Brake Company's complete line of Air Circuitry components. Pressure control, in addition to directional control, is obtained with the versatile "H" CONTROLAIR Valves. The position of its operator—lever, pedal, cam or knob—determines the air pressure delivered by the valve. Changing operator positions changes delivery pressure.

Precise pressure graduations may be made in one or two outlets to provide exacting remote control of variable force and positioning applications. Besides those functions illustrated a wide variety of pressure and directional control combinations is available. For details, ask for Catalog D4-65.00.

Applications for "H" CONTROLAIR Valves are limitless. They operate:

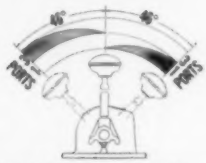
Throttles	Rolling Mills	Marine Propulsion Engines
Clutches	Presses	Construction Equipment
Brakes	Shears	Oil Drilling Rigs
Clamps	Conveyors	Production Tools
Gates	Dredges	Cranes and Shovels

and many other kinds of equipment and machines. In fact, "H" CONTROLAIR Valves are used wherever it is necessary, or preferable, to have instant and convenient control of the flow of air into a pneumatic circuit and of the pressure build up of air in that circuit.

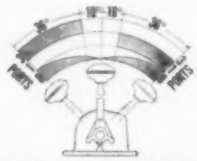
What is AIR CIRCUITRY?

This is the Westinghouse term for application of pneumatic control systems to industrial production operations. Safe, economical, precise AIR CIRCUITRY is now being used to solve the most rigorous and complex control problems in industry. Westinghouse Air Brake has pioneered the application and development of air control for more than 80 years. Today our engineers can design an air circuit which will help you boost production and cut costs in your plant or shop.

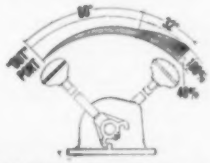
1. SINGLE LINE PRESSURE CONTROL—Pressure regulation in a single line is obtained through the H-2 CONTROLAIR Valve. This lever-operated, 3-way, pressure regulating valve increases, decreases or maintains outlet pressure according to its lever position. Several types of lever return or holding functions are available.



2. DIRECTIONAL PRESSURE CONTROL—The HC-2 CONTROLAIR Valve provides pressure graduation to either of two outlets. This lever-operated 4-way, pressure regulating directional valve consists of two 3-way directional valves and a 3-way pressure regulating portion. Lever movement either side of its "Neutral" position selects the outlet to be activated. Further lever movement in the same direction controls the pressure of the air delivered to that line.



3. DIRECTIONAL AND PRESSURE CONTROL—Pressure regulation plus full supply pressure directional control is possible with the HD-2 CONTROLAIR Valve. This lever-operated valve consists of two 3-way directional valves and a 3-way pressure regulating position. Each unit has its own outlet. Lever movement either side of "Neutral" provides full inlet pressure to a chosen outlet plus graduated pressure to a third outlet.



4. TWO RATE PRESSURE CONTROL—The first 60° of lever movement from the "Off" position provides an increase in delivery pressure from 0 to 40% of maximum value in the H-2-E type CONTROLAIR Valve. The remaining 32° of lever movement increases from 40% to its maximum value. Used in applications that require closer pressure adjustment at the low end of the delivery pressure range than at the high pressure end of the range.

See the Yellow Pages under Cylinders for the Name of Your Local Distributor

WESTINGHOUSE AIR BRAKE COMPANY
INDUSTRIAL PRODUCTS DIVISION, WILMERDING, PENNSYLVANIA

Circle **170** *on Time-Saver Card*

Why do hydraulic engineers specify Superior (SAE) Hydraulic Tubing for pressures up to 3000 psi?

Superior (SAE) Hydraulic Tubing meets both SAE Standards and AMS 5050E and ASTM A179 Specifications. But its usefulness goes much farther—it is widely selected for application in systems operating under pressures up to 3000 psi. There are many reasons for this preference. It has an ultimate tensile strength of 60,000 psi max., a yield strength of 25/45,000 psi, and an elongation of 35/45% in 2 in. It has a recommended maximum working pressure range of 530 to 11,750 psi, depending on OD and wall thickness. Every length is hydrostatically tested under maximum working pressure before shipment. It is made of nonaging steel, maximum carbon content 0.12%, and will therefore not become brittle in storage or service. It is specially coated with a waxlike rust preventive on both inside and outside surfaces, rather than being merely oil treated.

Superior (SAE) Hydraulic Tubing is better than pipe. It is easily bent—pipe fittings, which are subject to leakage, are eliminated. It does not require threading, which removes metal and weakens the wall. It absorbs vibration by reducing the number of fittings needed and by providing the required strength with minimum wall thickness. It has a bright, smooth, scalefree interior to minimize turbulence and pressure drop.

In addition to SAE Hydraulic Tubing, Superior offers more than 120 analyses of materials for fabrication into small diameter tubing. This wide range permits you to select the one that is just right for your specific application. For complete information, contact your nearest Superior distributor or write to us. Superior Tube Company, 2030 Germantown Ave., Norristown, Pa.

Superior Tube

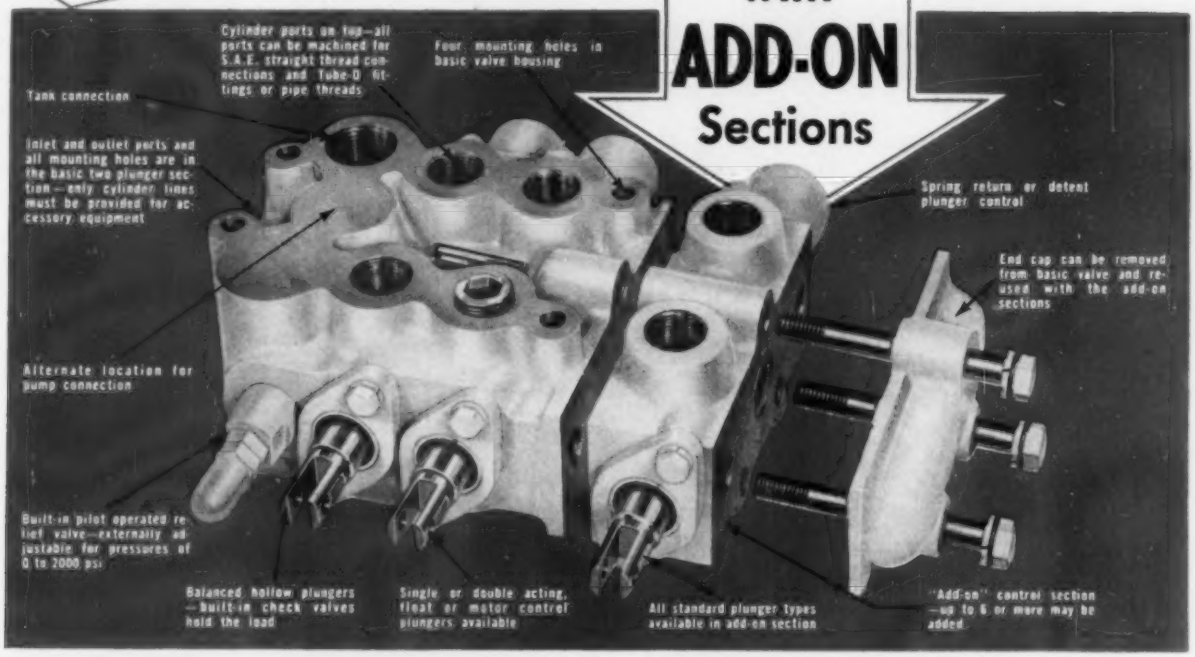
The big name in small tubing

NORRISTOWN, PA.

All analyses .010 in. to ⅝ in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

new HYDRECO® CONTROL VALVE with ADD-ON Sections


Cylinder ports on top—all ports can be machined for S.A.E. straight thread connections and Tube-O fittings or pipe threads
Four mounting holes in basic valve housing
Tank connection
Inlet and outlet ports and all mounting holes are in the basic two plunger section—only cylinder lines must be provided for accessory equipment
Spring return or detent plunger control
End cap can be removed from basic valve and re-used with the add-on sections
Alternate location for pump connection
Built-in pilot operated relief valve—externally adjustable for pressures of 0 to 2000 psi
Balanced hollow plungers—built-in check valves hold the load
Single or double acting, float or motor control plungers available
All standard plunger types available in add-on section
"Add-on" control section—up to 6 or more may be added

V-34 Series—for Field Mounting of Accessory Equipment on LIFT TRUCKS • INDUSTRIAL LOADERS • FARM MACHINERY

The HYDRECO V-34 Series "ADD-ON" type Valve, recommended up to 20 gpm operation and 2000 psi, has a basic 2-plunger cast-in-block section to which additional control sections (up to 6 or more), may be added at any time.

All mounting holes, tank and pump connections and relief valve are located in the basic section . . . control functions for added accessory equipment can be provided without disturbing the original installation.

V-34 "ADD-ON" sections are pre-tested. They are packaged for easy installation in the field or in the shop.

In the Field . . . Equipment dealers have a more salable accessory package with lower installation costs and better service to the customer.

In the Shop . . . Accessory equipment can be added to machines on the floor quickly and at low cost when HYDRECO V-34 Valves are on the original installation. Deliveries are expedited . . . inventories reduced. Only one reservoir or mounting configuration required for any number of control plungers.

V-34 SERIES VALVES FEATURE THESE ADDED ADVANTAGES:

- Low pressure drop through the cylinder circuit and the open center . . . V-34 Valves handle more than rated capacity with little loss in efficiency.
- Small in size and easy to install . . . no special fittings needed.
- Exceptional throttling and operator control . . . important for load lifting equipment.

HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY
9004-9 EAST MICHIGAN • KALAMAZOO • MICH

Please send me information on the New HYDRECO V-34 Valve.

Name_____

Company_____

Address_____

City_____ Zone_____ State_____

Revolutionary New ROCHESTER HIGH PRESSURE GAUGE
has pointer connected directly to pressure element

NO LINKAGES,
NO PIVOTS,
NO GEARS
to wear,
waver
or lag

This is the gauge for your toughest, your most exacting high pressure jobs!

3" and 5" Models No. 5020 and No. 5040. (Pressure ranges from 0-1000 to 0-10,000 p.s.i.)

Now you can practically eliminate maintenance, replacement, and gauge failures—even under the most severe of high pressure service conditions. The new RMC Gauge, models 5020 and 5040, actually approaches the reliability and dependability of the fittings and valves used in pressure equipment.

It is the first pressure gauge to have the pointer directly connected to the pressure element, without linkage or pivots, and with no gears or hair springs.

The pressure element is a multiple turn bourdon coil, to which the pointer is permanently attached at one end. As pressure increases, the end of the coil rotates, moving the pointer with it.

The bourdon coil is made from small diameter tubing. Therefore, the pressure forces against the coil are reduced; the mechanical stress on the coil is less; and spring life, cycling life, overpressure, and endurance are all vastly higher than the conventional "C" type bourdon tube gauge.

For safety, long cycling life and continued accuracy under extreme conditions of overload pressures, high vibration, shock and line pulsation, the new RMC High Pressure Gauge is the one complete answer. Available in pressure ranges from 0-1000 to 0-10,000 p.s.i.; dial diameters 1½", 2", 3" and 5". (1½" and 2" models are eccentric pivot-drive types.)

Write, wire or phone for complete information.

RMC **ROCHESTER MANUFACTURING CO., INC.**
209 Rockwood Street, Rochester 10, N. Y.

LIQUID LEVEL, TEMPERATURE and PRESSURE INSTRUMENTS

REPRESENTATIVES IN ALL PRINCIPAL CITIES
Circle **134** *on Time-Saver Card*

LETTERS

for I believe the missing link to my thesis in cylinder design lies in this text. Would Mr. Heiser have one available?

JOHN A. MICHNYA
National-U.S. Radiator Corp.
Johnstown, Pa.

We appreciate your need for a copy of the book, but our complete supply is exhausted. Even our file copy is in use. Some of our other publications might assist you. We have sent a list of these books, in addition to some information on our FLUID POWER DIRECTORY, *which will be useful to you.*

JIC Standards issue

TO THE EDITOR:

APPLIED HYDRAULICS & PNEUMATICS has performed a laudable service to engineering education and to industry in publishing the revised JIC Hydraulic Standards and in making reprints available at low cost.

R. D. MEADE
Secretary, National Conference on Industrial Hydraulics
Technology Center
Chicago, Ill.

Tells about drilled manifolds

TO THE EDITOR:

I have read with interest your June article pertaining to drilled manifolds on a swaging machine. We have manufactured drilled manifolds for many years. We have many varieties, some having as many as 300 holes. These manifolds have proven so satisfactory that they are standard equipment on all our machines requiring both pneumatic and hydraulic equipment. These panels are cross drilled so the entire circuit is inside with only the cylinder and pump lines outside. We are now working on a version on which an O-ring mounted pump is used on the panel, eliminating suction and pressure lines.

FRANK REYNOLDS, JR.
Engineer
Barnes Drill Co.
Rockford, Ill.

Continued on page 20

HOUGHTON

THE ONLY COMPLETE LINE OF PACKINGS & FLUIDS FOR ANY INDUSTRIAL HYDRAULIC SYSTEM

This unique feature of Houghton hydraulic service is your guarantee of a completely unbiased recommendation for compatible packings and fluids.

Houghton's reputation for leadership in both fields, is your guarantee of the best packings and fluids for the job.

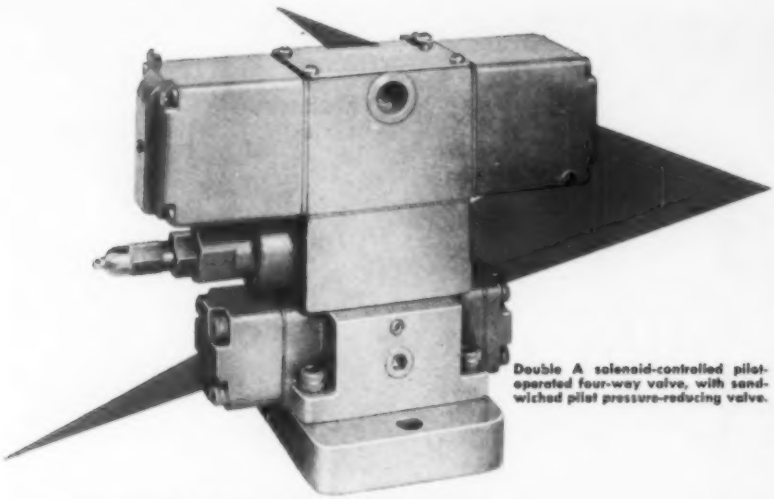
E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

HYDRO-DRIVE & HOUGHTO-SAFE FLUIDS
VIM & VIX-SYN PACKINGS . . .

. . . products of E. F. HOUGHTON & CO.

Ready to give you on-the-job service

Philadelphia, Pa. • Chicago, Ill. • Carrollton, Ga. Detroit, Mich. • San Francisco, Calif. • Toronto, Canada



Double A solenoid-controlled pilot-operated four-way valve, with sandwiched pilot pressure-reducing valve.

From Brown & Sharpe—

These Big Double A Valve Features

Get *all* the features *you want* in the valves you buy. Get JIC standards *plus* these extra features and choices by buying Double A solenoid-controlled, pilot-operated directional valves:

- **Choose from four different solenoids: AC, DC, AC oil-immersed, and DC with palm-button.**
- **Solenoids have rubber shock absorbers and exclusive separate drain for more reliable, faster action.**
- **Just one solenoid and pilot valve combination will serve four valve bodies with pipe connections from ⅜" through 2", and three pressure capacities (2,000, 3,000, and 5,000 psi).**
- **New optional CircuitStak pilot pressure-reducing valve sandwiches between main body and pilot valve to make possible higher pressure operation of the main valve body.**
- **New optional CircuitStak pilot flow-amplifying valve requires no piping, provides faster spool shifting of larger valve sizes.**
- **Fifteen different standard cataloged main valve spool types are available, to accurately match your demands.**
- **Two kinds of sub-plates, the usual back-entering plus the back-and-side entering type, are offered.**
- **SAE straight thread openings are optional at no extra cost.**

See for yourself how much more Double A valves offer, from the sensible flow ratings (based on *minimum* pressure drops) right down to the extra mounting bolts (to prevent O-ring troubles under high pressures). Contact your nearest Double A hydraulic distributor. Or write to **Double A Products Co.,** a subsidiary of Brown & Sharpe Mfg. Co., Manchester, Michigan.

Brown & Sharpe
HYDRAULICS DIVISION

GEAR, VANE & CENTRIFUGAL PUMPS
DOUBLE A VALVES
GEROTOR PUMPS
POWER UNITS

B·S

PROGRESS IN PRECISION FOR OVER 125 YEARS

COMPLETE INFORMATION
on Double A solenoid-controlled sub-plate mounted four-way valves.
ASK FOR
Series 9000 Engineering Data Sheets.

Circle **49** *on Time-Saver Card*

LETTERS

Needs bibliography of hydraulic manuals

TO THE EDITOR:

Does your company still have available a bibliography of manuals, texts, and leading manufacturers' technical literature dealing with Industrial Hydraulics similar to the 1955 APPLIED HYDRAULICS Data List? If it is available, please send me a copy.

MARVIN L. WOLF
Design Engineer
Cessna Aircraft Co.
Hutchinson, Kan.

We no longer publish the separate bibliography you mention. We do include two pages of information on books and films in our FLUID POWER DIRECTORY. *You'll find this information in the "Fluid Power Design" section of the Directory.*

Wants agenda for two fall meetings

TO THE EDITOR:

I would like to obtain a copy of the proposed agenda for the 15th Annual NCIH in Chicago, Oct. 22-23 and the Annual Fall Meeting of the National Fluid Power Association in Detroit Oct. 26-28. If you are unable to supply the agenda for these meetings, I would appreciate information on where they could be obtained.

DAN GRIFFIN
Experimental Engineering Dept.
General Motors Corporation
Proving Ground Section
Milford, Mich.

You'll find preliminary NCIH program details in the Briefs section of this issue. The October issue of AH&P will include the complete program and abstracts of papers. You can make reservations to attend by writing Raymond D. Meade, NCIH, Illinois Institute of Technology, 3300 S. Federal St., Chicago. The program for the Fluid Power Association meeting isn't ready yet. This is a trade association with membership limited to manufacturers of hydraulic and pneumatic components. □□□

IF IT ISN'T MADE BY BELLOWS . . .

it isn't a HYDRO-CHECK*

*TM Registered U.S. Patent Office. No. 527,974

Hydraulic checking of the movement of an air cylinder piston rod smooths out the natural "bounce" or "springiness" of air—gives to air power perfect smoothness, complete freedom from chattering.

Hydraulic checking of air cylinder power has become standard in practically any pneumatic operation involving precision control.

Our registered trade mark for such hydraulic checking devices is "HYDRO-CHECK." The Bellows Hydro-Check has become so popular and is used so widely for precision control of pneumatic or even manual power, that many imitators have appeared on the market—but there is only one HYDRO-CHECK and it is manufactured by The Bellows Co. *If it isn't made by Bellows it isn't a Hydro-Check.*

OTHER REGISTERED TRADE MARKS OF THE BELLOWS CO.

THE BELLOWS AIR MOTOR — the air cylinder with the built-in valve and operating controls.

THE SUPER-SPEED AIR MOTOR — the air cylinder with twice the speed — twice the power.

ELECTROAIRE — the electrically controlled four-way valve for integral mounting on the Bellows Air Motor or for remote control of any air cylinder of suitable capacity.

PULSA-PAK — an electrical control device to permit maintained circuits yet provide a momentary electrical impulse.

SENSITORQUE — a torque-sensing unit for control of deep hole drilling operations.

CARBI-DRILL — heavy-duty drill unit.

LUBRI-AIR — a unit to filter, pressure regulate and lubricate compressed air.

POWER-DOME — plain air cylinders featuring dome head construction.

1493-B

Would you like to know more about the many models and sizes of Bellows Hydro-Checks? What they are — how they work — how you can use it to obtain precision control of air cylinder movement? Write today for Bulletin HC-600R. Address Dept. AH959, The Bellows Co., Akron 9, Ohio.

The Bellows Co.

DIVISION OF INTERNATIONAL BASIC ECONOMY CORPORATION (IBEC)

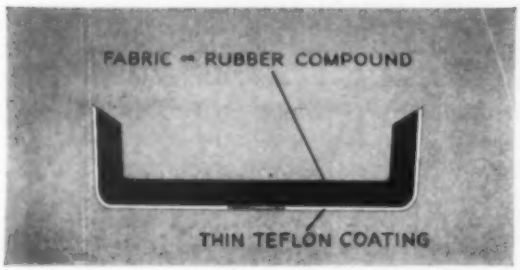
AKRON 9, OHIO

OTHER INDUSTRIAL DIVISIONS OF IBEC: Sinclair-Collins Valve Co., Valvair, Akron, Ohio • V. D. Anderson Co., Cleveland, Ohio

NEWEST OF THE GARLOCK 2,000

First Advance in Cup Design in 30 Years

New Garlock TEFLON-Coated Cups



Cutaway shows how TEFLON coating is applied to outer surface of molded cup by special Garlock process. Coating becomes integral part of outer surface.

This exclusive Garlock development will substantially improve the operation of your hydraulic or pneumatic equipment.

TEFLON-coated cups reduce the breakaway torque required to operate cylinders; reduce running friction; will not stick to cylinder walls even after long periods of idleness. Completely eliminate "squealing." All this, of course, results in longer life, less downtime.

TEFLON, with its low coefficient of friction and anti-sticking characteristics, has for many years resisted the efforts of manufacturers to use it as a coating. The very anti-sticking qualities that make it desirable, also made it difficult to work with. Now Garlock has perfected a technique for coating molded cups with a thin layer of TEFLON. This coating becomes an integral part of the cup.

Most important, of course, TEFLON-coated cups are low in cost, only slightly higher than ordinary cups.

Get full information on this newest member of "the Garlock 2,000" . . . two thousand styles of packings, gaskets, and seals for every need. Call your local Garlock representative or write for Folder 145. You'll find information on other Garlock products in Sweet's Product Design File.

Other New Garlock TEFLON-Coated Products

To reduce friction and reduce downtime at low cost on applications using V-type packings or O-rings Garlock also furnishes TEFLON-coated CHEVRON* packing and TEFLON-coated O-rings. Both have the same exceptional anti-friction qualities of TEFLON-coated cups. These products are available in all the standard sizes. Write for CHEVRON folder AD-115; or O-Ring Folder AD-148.

*Registered Trademark

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

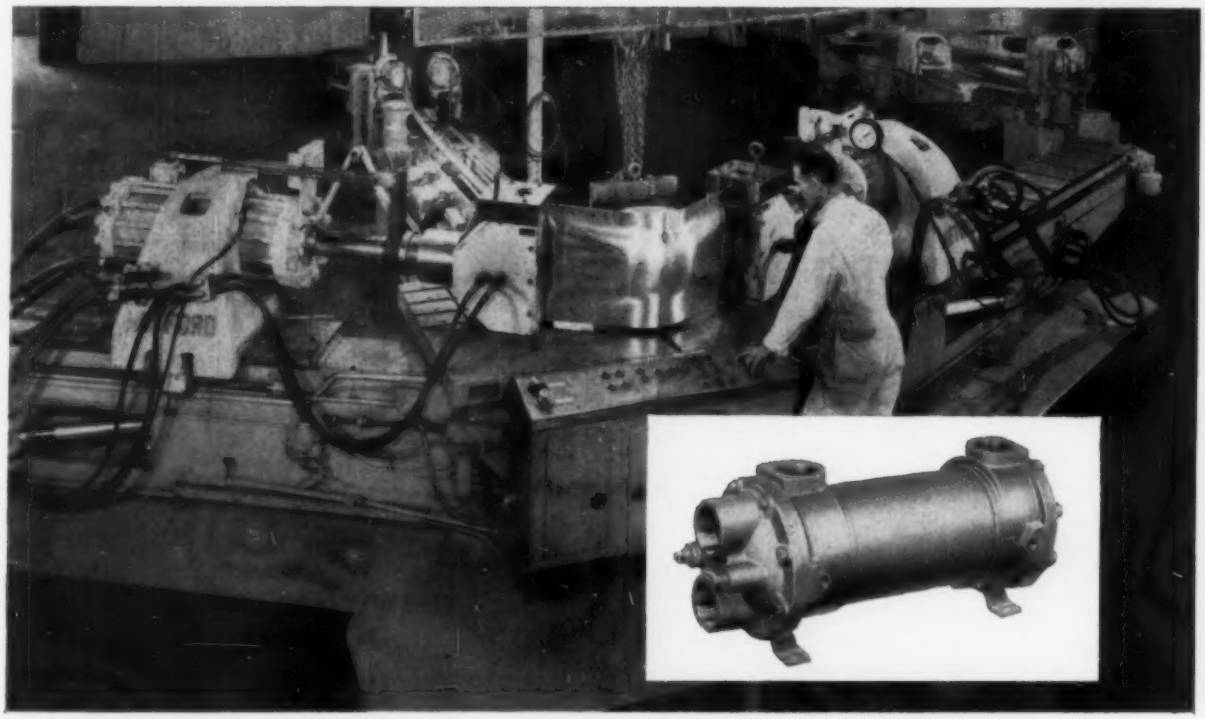
For Prompt Service, contact one of our 26 sales offices and warehouses throughout the U. S. and Canada

GARLOCK

Packings, Gaskets, Oil Seals, Mechanical Seals, Molded and Extruded Rubber, Plastic Products

Circle **61** on Time-Saver Card

hydraulic fluid cooled by Ross Exchangers



Radar reflectors pulled into shape with 118,000 pound stretch

Shaping aluminum radar reflectors, this Hufford Hydraulic Stretch-Wrap Forming Machine exerts up to 118,000 pounds of pull with its powerful jaws. With the metal drawn to its yield point and wrapped around a stationary die, curvature is compounded in two directions without wrinkles.

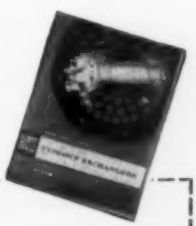
To maintain consistent hydraulic pressures by preventing pump slippage from overheated, thinned oil, a Ross Type BCF Exchanger was installed as original equipment. Even under highest pressure, hydraulic temperature remains within desired limits. *Efficient cooling is assured.*

Says Hufford Machine Works, Inc., "Ross Exchangers are compact, easy to install and perform satisfactorily . . . We have been using them for years."

First in ruggedness and high thermal efficiency, Ross Exchangers are regularly furnished with practically every type and make of hydraulic machinery: die casters, metal drawing presses, extrusion presses, gear shapers, powdered metal presses and fluid drives.

Recently redesigned, Ross Type BCF Exchangers feature *new* flanged-lip baffles for tighter tube fit and improved thermal characteristics, *new* movable feet for easy installation, *new* materials, *new* sizes and capacities in one, two or four pass designs.

For detailed information on these pre-engineered, fully standardized units, use coupon below to request new Bulletin 1.1K6



TO:
American-Standard*
Industrial Division
Detroit 32, Mich.

AH-959

Please send, without obligation, your new Bulletin 1.1K6 describing the redesigned Ross Type BCF Heat Exchanger.

NAME _____

TITLE _____

COMPANY _____

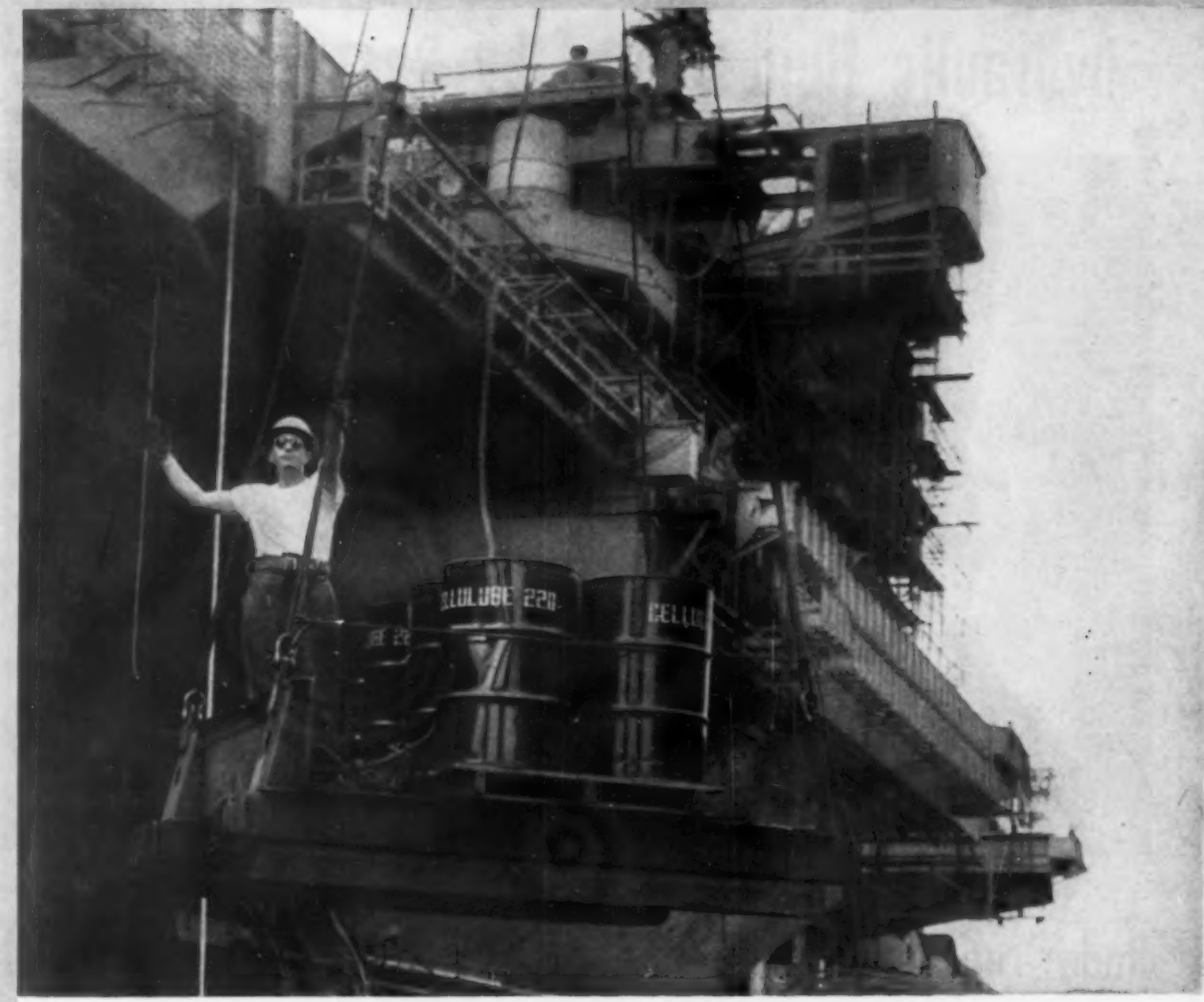
ADDRESS _____

CITY _____ ZONE _____ STATE _____

*American-Standard and Standard ® are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
INDUSTRIAL DIVISION

AMERICAN BLOWER PRODUCTS • KEWANEE PRODUCTS • ROSS PRODUCTS



Cellulubes by Celanese shoulder the big jobs . . .

In standard tests, Cellulubes were dripped and flooded onto molten metal at 1500° F without igniting! In a standard flammability test, Cellulubes were sprayed under pressure onto burning oil-soaked cotton waste; they actually extinguished the fire on a portion of the flaming material!

No wonder Cellulubes made by the Celanese Corporation of America are specified for big jobs in hydraulics which present potential fire hazards.

FM

Factory Mutual-Approved
(Cellulubes 150 and 220)

CELANESE CORPORATION OF AMERICA, CHEMICAL DIVISION
DEPT. 588 · 180 MADISON AVENUE, NEW YORK 16, N. Y.

Please send me:

☐ Technical bulletin ☐ Sample of _____ viscosity.

Name _____ Title _____

Company _____

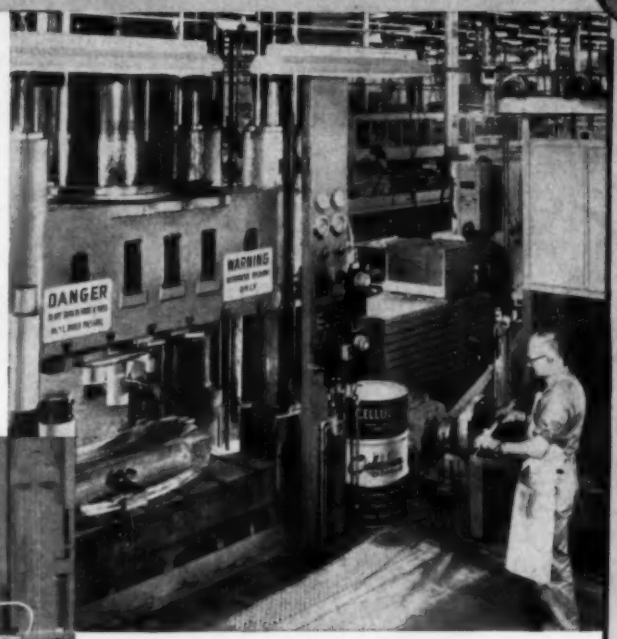
Address _____

City _____ Zone _____ State _____

Application I have in mind _____

U.S.S. INDEPENDENCE, the Navy's newest 60,000-ton supercarrier, takes on 55-gallon drums of Cellulube, part of a six-car trainload. Used to operate giant aircraft elevators, Cellulubes overcome the hazard of fire and explosion. Cellulubes are used in the combat fleet for fire-safe hydraulic duty.

TITANIUM PARTS expanded by heating to 1000°F are transferred from an electric furnace to a powerful hydraulic press. North American Aviation uses fire-resistant Cellulube 220 to protect against the dangers of line fracture or leakage during this form-die quenching operation for making high-strength aircraft parts.



DIE-CASTING MACHINES at Alcoa's Garwood plant are hydraulically actuated. Furnace in foreground shows the proximity of the lines to the molten metal. Lines operate at pressures up to 3500 psi. Cellulube hydraulic fluids minimize the danger of fire.

reduce fire hazards near hydraulic machines

Wherever hydraulic lines pass near a source of ignition, fire-resistant Cellulubes are a must.

The fluids are available in six ranges of viscosity, and they maintain these viscosities under the severest conditions of mechanical shear. Cellulubes display excellent physical and chemical stability. They do not foam, cannot drop additives into the system. In fact, they actually have a cleansing action in machinery. Low compressibility insures efficient power transfer. The good lubricant properties of Cellulubes safeguard equipment life and decrease maintenance.

Let us help you with your hydraulic problems wherever a hazard might exist. Celanese, pioneer in fire-resistant functional fluids, can draw on long field experience and research background in solving your problem. For full technical specifications, send for the "Cellulube Safety Series" manual. If you'd like a sample of Cellulube, please let us know what application you have in mind.

Celanese Corporation of America, Chemical Division, 180 Madison Ave., New York 16, N. Y.

Celanese® Cellulube®

Cellulubes... Celanese CHEMICALS fire-resistant functional fluids

In Canada: Canadian Chemical Company Limited, 2035 Guy St., Montreal, Toronto, Vancouver • Export Sales: Amcel Co., Inc., and Pan Amcel Co. Inc., 180 Madison Ave., New York 16

CELANESE CELLULUBES

How B&W JOB-MATCHED TUBING simplifies fabrication of hydraulic cylinders

... The complete range of sizes and types of finish plus close tolerances help to simplify fabricating operations.

... Quality control from start to finish in the tube making operations helps to speed up fabrication and to make a better product.

... Controlled heat treatment provides desired properties for ease of fabrication.

These are just a few of the reasons it pays to specify B&W Job-Matched Mechanical Tubing.

Call the tubing specialist at your local B&W District Sales Office, or write for Bulletin TB-352 for full information. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pennsylvania.

Metal Show—Booth 528
International Amphitheater
Chicago—November 2-6

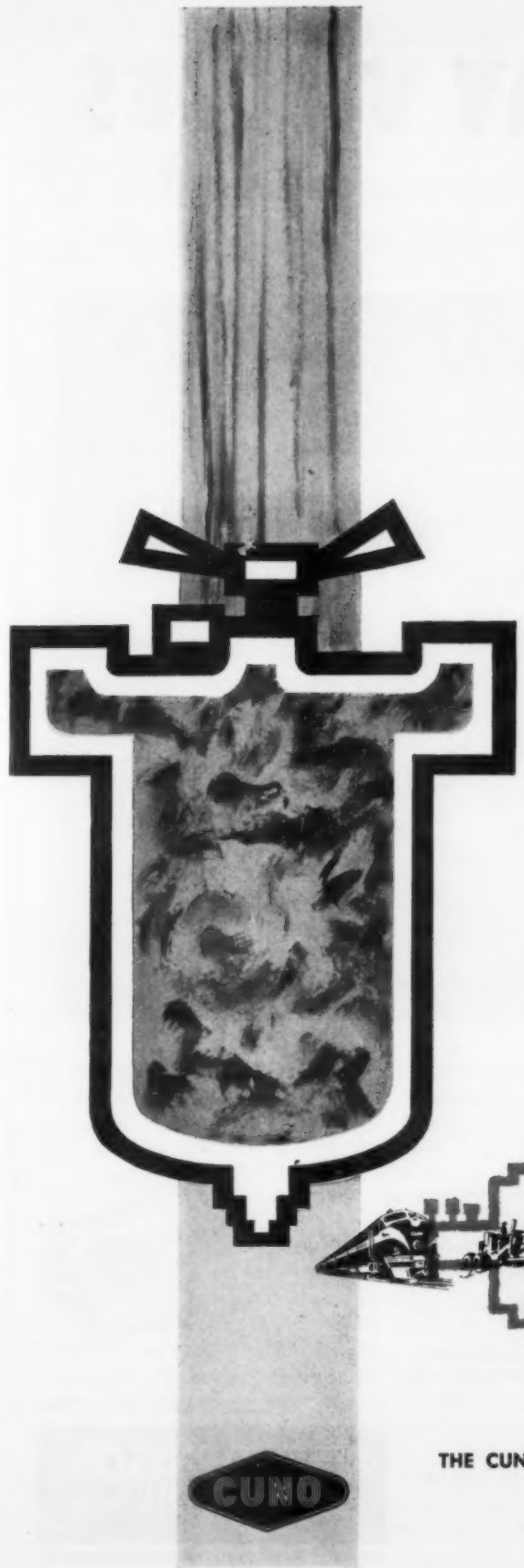
B&W

THE BABCOCK & WILCOX COMPANY

TUBULAR PRODUCTS DIVISION

TA-9008-SM3

Seamless and welded tubular products, solid extrusions, seamless welding fittings and forged steel flanges—in carbon, alloy and stainless steels and special metals

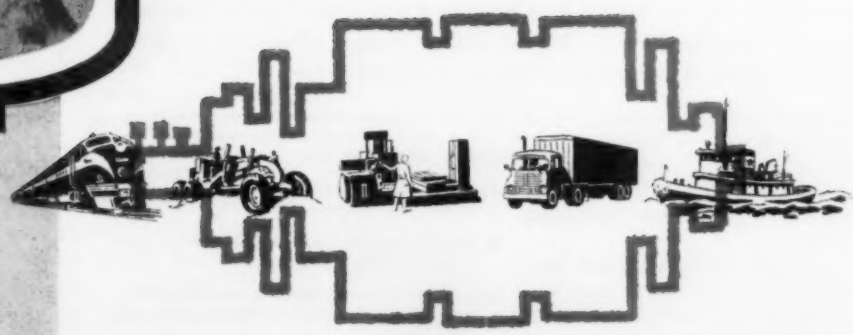


whatever the **power production application . . .** you can depend on **CUNO** engineered filtration

"The more complete the filtration, the more efficient the production of power." Cuno filters remove damaging contaminates and reduce costly stoppages.

To meet the specific requirements of *your* power production application, Cuno provides effective, engineered filtration with . . . Auto-Klean Self-Cleaning Edge-Type, Flo-Klean Automatic Self-Cleaning Wire Wound, Micro-Klean Disposable Depth Cartridge . . . available in a variety of housings.

Let us apply over 30 years of filtration know-how to *your* requirements.



THE CUNO ENGINEERING CORP., DEPT. 13, MERIDEN, CONN.

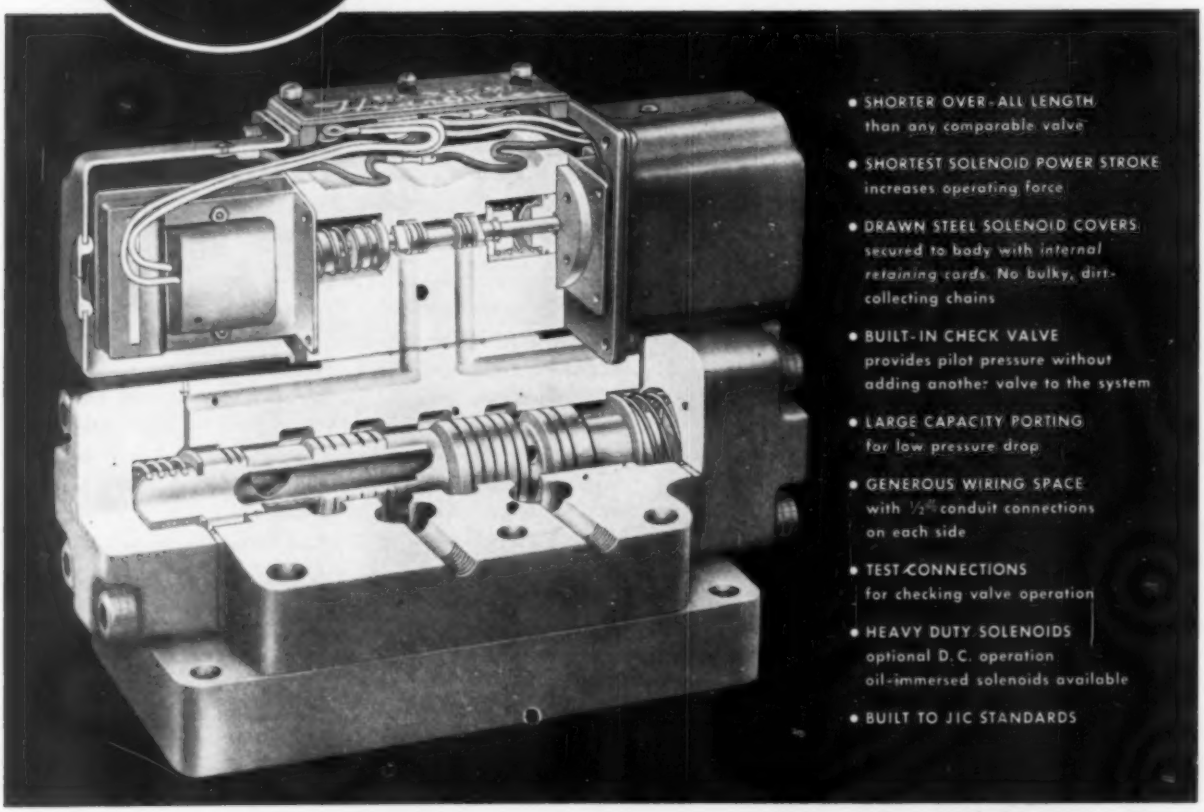
A Leader in Industrial Filtration for More Than 30 Years

Sales Offices throughout the United States and Canada
In Canada write: Peacock Bros., Ltd., P.O. Box 1040, Montreal 3, P.Q.

NEW from DENISON

4-WAY VALVES

Pilot-operated, solenoid-controlled for hydraulic systems up to 5000 psi



- SHORTER OVER-ALL LENGTH than any comparable valve
- SHORTEST SOLENOID POWER STROKE increases operating force
- DRAWN STEEL SOLENOID COVERS secured to body with *internal retaining cards*. No bulky, dirt-collecting chains
- BUILT-IN CHECK VALVE provides pilot pressure without adding another valve to the system
- LARGE CAPACITY PORTING for low pressure drop
- GENEROUS WIRING SPACE with ½" conduit connections on each side
- TEST CONNECTIONS for checking valve operation
- HEAVY DUTY SOLENOIDS optional D.C. operation oil-immersed solenoids available
- BUILT TO JIC STANDARDS

SHOCKLESS HYDRAULIC CONTROL for any directional control requirement is assured with Denison's new line of 4-Way Valves.

Here are *more reasons why* the exceptional design versatility of these new 4-Way Valves is important to Hydraulic Engineers—

1. Provide fast, rapid-cycle directional control of hydraulic flows up to 30 gpm.
2. Operating pressures range up to 5000 psi for both ¼" and ¾" valve sizes.
3. Operate in any porting and positioning combination.
4. Solenoid-operated ¼" valve capacity—5 gpm.
5. Pilot-operated, solenoid-controlled ¾" valve capacity—30 gpm.
6. Choice of spool types and spool positioning provides unlimited combinations for a wide range of applications.
7. Adjustable pilot chokes available for smooth spool reversal.
8. Interchangeable parts simplify service and model changes in the field.
9. Easily modified for operation on internal or external pilot pressure by rotating solenoid valve 180°.

DESIGNERS ENGINEERS!

Send for Bulletins VD-7, VD-8 and 240-B

for full details write

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1166 Dublin Road • Columbus 16, Ohio

Denison Stocking Branch Offices: LOS ANGELES • CHICAGO
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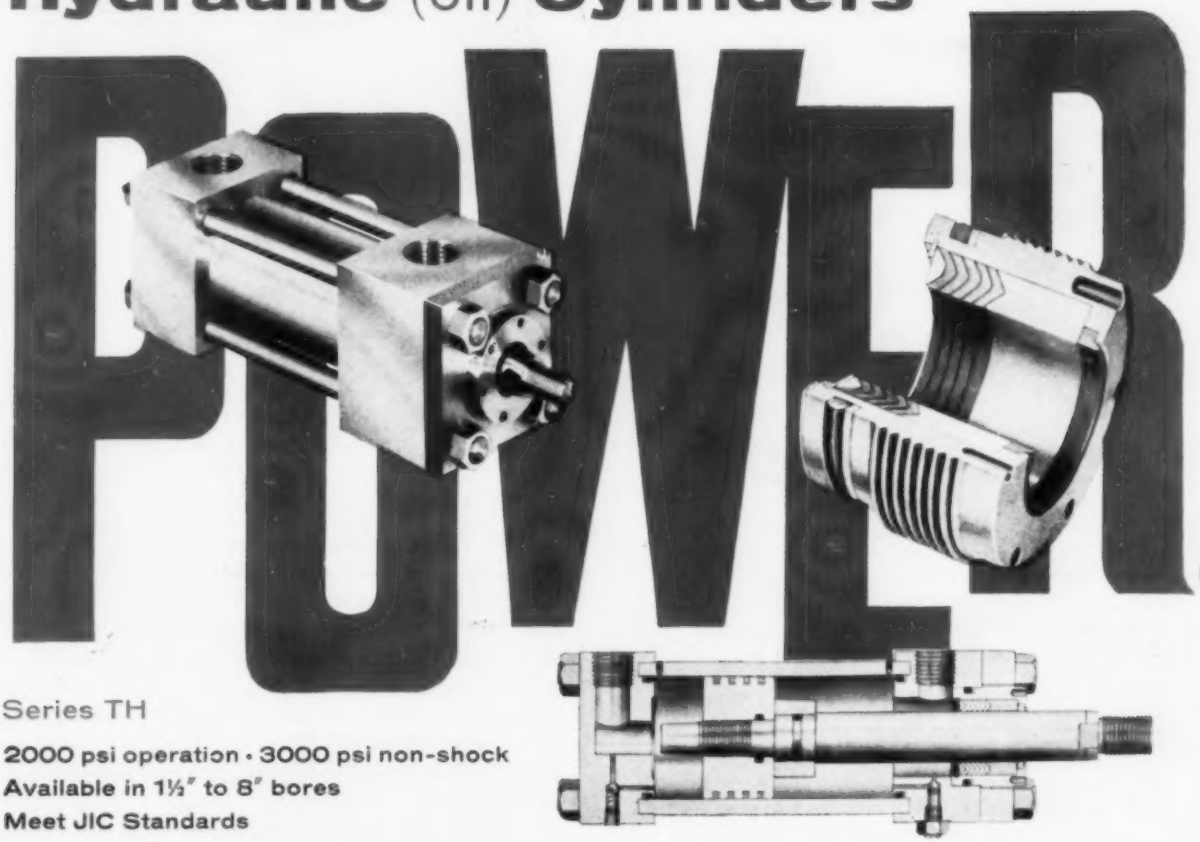
DENISON HydrOILics

HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

Circle **46** on *Time-Saver Card*

there is **power**
to spare in
O-M heavy-duty
Hydraulic (oil) **Cylinders**



Series TH

2000 psi operation · 3000 psi non-shock
Available in 1½" to 8" bores
Meet JIC Standards

IF you need smooth, dependable straight-line motion for heavy-duty pushing, pulling, elevating, lowering, clamping or knock-out operations, these powerful, O-M components have what it takes and more, too. To deliver this plus in power, every essential design and construction feature has been employed.

For example, these units are ruggedly constructed of heavy wall seamless steel tubing microhoned to minimize friction. The ports are large and unrestricted. They can be located at 90-degree positions. These cylinders are sealed right to prevent power loss. The piston rod is stress relieved, turned, ground and polished, high tensile steel, chrome plated. In addition, the rod gland cartridge, accurately piloted in the rod head to assure perfect alignment, is easily unscrewed and removed. Pilot O.D. of cartridge serves as pilot for cylinders mounted on rod end. A cushion ball check valve provides for rapid, full power start of return stroke.

These and many other advancements are described in our latest catalog No. 105. Write for your copy TODAY or consult your local O-M representative.

ORTMAN-MILLER MACHINE COMPANY
1143rd Street, Hammond, Indiana

☐ Have representative call
☐ Send Bulletin 105

Name_____ Position_____
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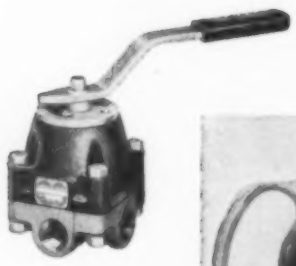
For High Pressure (to 6000 P.S.I.)

MANUAL WATER VALVES

that last

Specify "SHEAR-SEAL" design



4-Way, Manipulator, Dual pressure and Shut-off Valves from ¼ to 1½" N.P.T.

Note the mirrorlike sealing surfaces on this Dual Pressure Valve rotor after 4 years of service.

On extrusion presses, die casting machines, rubber and plastic molding presses and on blowout preventers, they have performed without maintenance longer than any other type of valve.

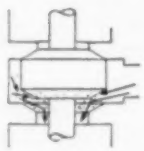
This LONG, MAINTENANCE-FREE SERVICE is possible because the metal-to-metal sealing surfaces are self-aligning and actually improve with use through continued lapping action. Sealing qualities do not diminish because a spring compensates for the wear.

DIRT CANNOT SCORE SEALS because flow is through "Shear-Seals," sealing surfaces remain in constant intimate contact.

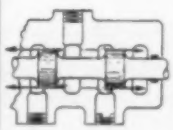
COMPLETE CONTROL OF YOUR CIRCUIT because "Shear-Seal" design is excellent for throttling. It permits opening to any desired degree of flow with smooth action and without fighting fluid pressure.

The "Shear-Seal" action eliminates line surges and the round tubular flow passages provide more flow and velocity capacity (up to 60 ft. per sec.) because they are unobstructed by spools or poppets.

This is why we don't use **SPOOL OR POPPET DESIGN**



Poppets score



Spools leak

Write for Catalog V-59-60

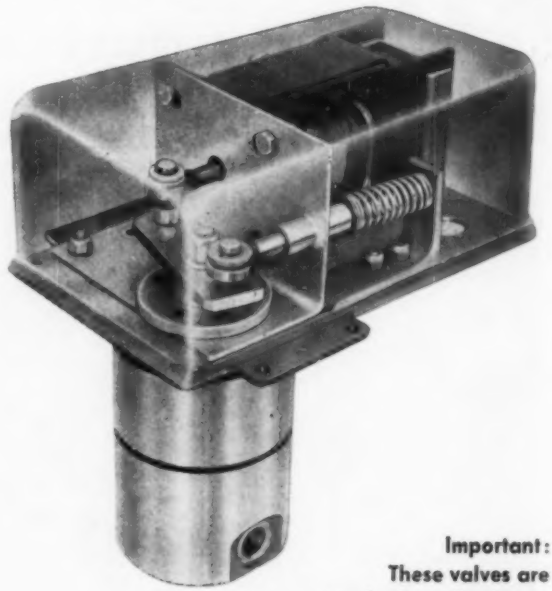
CONTROL VALVE DIVISION

barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Circle **19** *on Time-Saver Card*

10,000 P.S.I. SOLENOID VALVES



Important: These valves are standard catalog items.

● They are available for immediate delivery (in stock) at standard valve prices, for a service which generally requires costly (made-to-order) special valves.

● Shut off and 4-way valves in ¼, ⅜ and ½ inch port sizes are rated for 10,000 P.S.I. liquid or gases. They will withstand surges of up to 15,000 P.S.I. without damage to the valves' sealing qualities (designed for a burst pressure of 30,000 P.S.I.).
Solenoids are available for 115, 230 and 460 volt A.C. operation.

● Long maintenance-free service is achieved through the leak-proof "Shear-Seal" design. Optically flat metal to metal sealing surfaces (of the self-aligning sealing rings and the mating rotor face) are protected by staying in constant intimate contact: flow is always through the center of the "Shear-Seals," never across sealing surfaces. Sealing qualities actually improve as the seals lap themselves to a more perfect fit with each valve operation. There is no external shaft leakage because the pressure is confined to the flow passages.

For complete data write for catalog S-10000.

CONTROL VALVE DIVISION

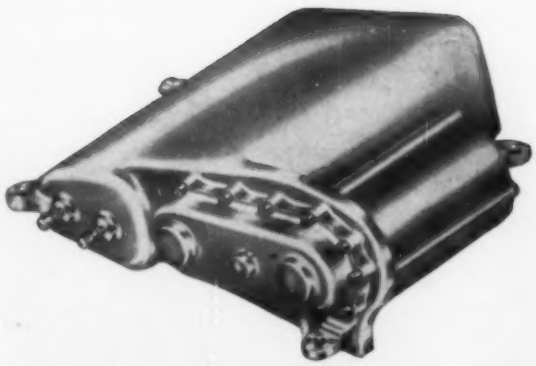
barksdale valves

5125 ALCOA AVENUE • LOS ANGELES 58 • CALIFORNIA

Circle **20** *on Time-Saver Card*

Stratopower can't afford to stay in step- We have to stay ahead...

years ahead in hydraulic development



STRATOPOWER keeps years ahead in hydraulic development by advanced theorizing, advanced research and testing ... and with the most advanced precision production facilities in the world. Here, for example, is a STRATOPOWER Hydraulic Package being built for a new missile project ... calling for "years ahead" hydraulic technology.

STRATOPOWER Hydraulic Packages and Systems are perfect examples of being "made for each other." They contain everything you need, including specified performance. Reservoirs, accumulators, valves, pumps, motors and even plumbing, are all mated into a smoothly functioning unit.

The heart of these Packages and Systems is the constant or variable displacement STRATOPOWER Hydraulic Pump. Models are available to operate dependably up to 450° F., and at exceptionally high speeds.

The advanced designs of STRATOPOWER Hydraulic Pumps are made practical by precision manufacturing that makes watchmakers' standards seem clumsy by comparison. 50 millionths of an inch are tolerances found in production models. Specify STRATOPOWER Pumps, Motors, Packages or Systems, and you, yourself, take a giant step ahead of the competition.

WRITE TODAY: *See how your hydraulic power application is best fulfilled by STRATOPOWER Hydraulic Pumps, Packages and Systems ... it's a step in the right direction!*

WATERTOWN DIVISION
THE NEW YORK AIR BRAKE COMPANY
STARBUCK AVENUE • WATERTOWN • N. Y.

BRIEFS

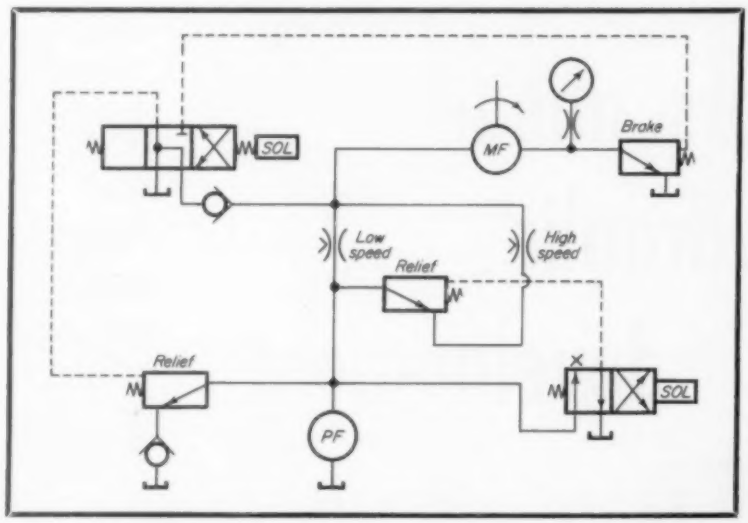
about fluid power

USING HYDRAULICS MAKES PIPE CASTING SIMPLE

A simpler, more efficient casting of pipe is being obtained by a hydraulically-operated centrifugal casting machine, which handles the entire operation of producing pipe up to four meters in length.

The hydraulic system provides single operator control over the basic functions—rotating a permanent mold, pouring molten metal, and ejecting the finished casting.

Designed and built by the Centrifugal Casting Machine Co., Tulsa, the machine is capable of producing between 30-40 cast iron pipes an hour, depending on pipe size.



Centrifuge drive hydraulic circuit.

Courtesy Denison Engineering Div., American Brake Shoe Co.

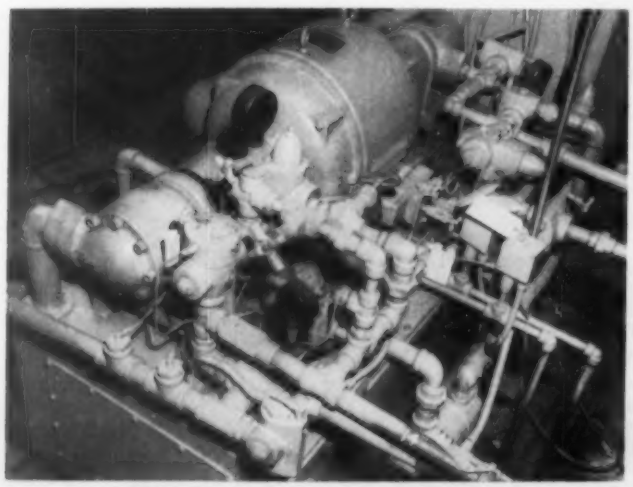
• **How it works**—The machine starts rotating as the hydraulic operator handle is placed into position. #1. At the same time the ladle car runner pot moves axially into the mold, elevating the ladle.

With the handle in the #2 position, the hydraulic motors accelerate the machine to full spinning speed and turn on the water-cooling jets. This position also starts a timer which controls a preset time in which the mold spins.

The machine automatically stops, the wedges holding the cores are knocked out, and the hydraulic control handle is advanced to top position #3.

In the third position the pull-out extractor tool engages the i.d. of the pipe, automatically revers-

Continued on page 34



Close-up of 2000 psi vane pumps and drive motor.

Central electronic control panel.

Circle 77 ➡

another

new valve

by **HUNT**

the **TRIM LINE**

1. Pilot operated — spring returned
2. Double pilot operated
3. Pilot operated — bucking cylinder returned
4. Lever operated
5. Reserved for valve actions to come
6. Palm-button operated
7. Ball actuated

An unbelievably small valve with a long, long life

Priced economically . . . that's TRIM LINE, Hunt's newest valve in a series of new valve designs.

The TRIM LINE is available in 3-way and 4-way actions. Furnished tapped for either ⅛" or ¼" pipe connections.

Designed for installations where space is limited, TRIM LINE is a quality valve you can depend on to work right . . . and to LAST. Just replace the "O" rings and it works on and on and on.

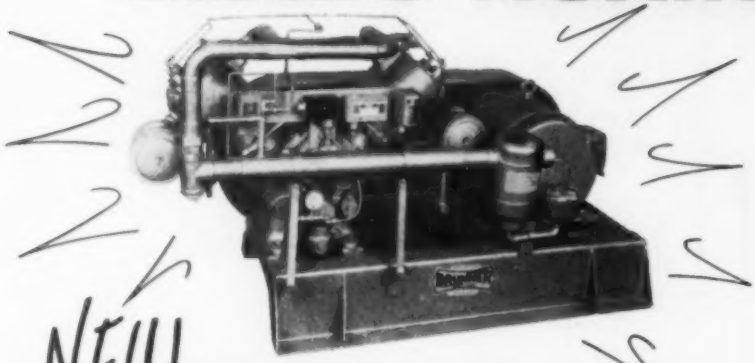
For complete details write to . . .

HUNT VALVE COMPANY • SALEM, OHIO, U.S.A.

HUNT ***Quick-As-Wink*** AIR & HYDRAULIC CONTROL VALVES

BRUNNER
SINCE 1906

LEADS AGAIN



NEW WATER COOLED
AIR COMPRESSOR LINE

Since 1906, Brunner has lead with the latest in air compressors. Now the WJ and WK (10 thru 30 HP) water cooled line joins the famous family of Brunner compressors from ¼ thru 50 HP.

6 good reasons why
Brunner is preferred

BRUNNER Air Compressors:

- Are outstandingly dependable
- Provide oil and moisture free air
- Offer single or 2 stage equipment in all sizes
- Supply complete air or water cooled aftercooler assemblies with all fittings from one dependable source for all compressor sizes
- Provide "entire system" duplex units that are "operation readied" to connect to piping and wiring facilities
- Air conditioning and heating experience of Dunham-Bush engineers enables them to professionally assist in layout for dependable control systems.

ALSO WATER COOLED AFTERCOOLERS AND OTHER ACCESSORIES BY heat-x A DUNHAM-BUSH SUBSIDIARY

REQUEST:

- Bulletin #763 for water cooled specifications
- Catalog #36 for ½ through 20 H.P. data
- Catalog #37 for 25-30-40-50 H.P. industrial information

BRUNNER DIVISION
DUNHAM-BUSH, INC.
DEPT. AH. WEST HARTFORD 10, CONNECTICUT

Circle 50 on Time-Saver Card

BRIEFS

ing and pulling the pipe from the mold.

• **Hydraulic system**—The hydraulic system which controls the machine is divided into three basic circuits: (1) centrifuge drive; (2) puller car, and (3) accessories. All circuits are controlled through the central panel.

The pumping unit consists of three pumps and reservoir. Suction strainers available on each pump are accessible through hand cleanout holes.

• **Provides variable torque**—The centrifuge drive provides variable torque which determines acceleration rate of the mold, and infinitely variable speed from 100-850 rpm. The two preset speeds are selected independently.

A special relief valve is used with needle valves to keep constant flow and speed regardless of load. The relief valve senses pressure drop across the needle valve and bleeds off pump flow to maintain a constant differential pressure across the needle valve.

Since the differential pressure drop across the needle valve is constant and independent of the overall system pressure, precise speed control is maintained regardless of load.

Oil, which does not produce rotation of the fluid motor is bypassed through the relief valve at system pressure.

The pump is a vane type, 2000 psi, 33 gpm, 36.2 hp input, and foot mounted. □□□

Hydraulics Improves 20-Ton Bending Press

Improvements in a new 20-ton bending press include a ram cylinder deceleration circuit assuring greater bending accuracy and internally drained hydraulic cylinders preventing oil leakage around piston rods.

This press, manufactured by Pines Engineering Co., Inc., Aurora, Ill., provides dependable service on work to maximum steel

Continued on page 36

Front Panel — Electrical Control Assembly

All-New CI LEAKMETER *Automatically Measures Hydraulic or Fuel Leakage!*

The measurement of leakage by counting or gauging drops is now obsolete! Convair Instruments' all-new LEAKMETER Model 400, when installed in a line between a pressure source and the system or component under test, will positively indicate, by a signal light, the presence of a leak, and will accurately measure its magnitude.

Operation of the LEAKMETER is automatic with a built-in timer which can be set for periods of 15 seconds to 5 minutes, providing a range for the instrument of 0.008 to 80 cc per minute. To measure other rates of leakage, or to test for sustained zero leakage, the timer may be overridden and the test conducted over any desired period.

PRINCIPLE: Fluid leakage is translated by a displacement transducer into a proportional electrical signal which is indicated in cubic centimeters by a meter housed in an electrical control unit. **EASE OF OPERATION:** The hydraulic transducer assembly is packaged separately from the electrical control assembly, permitting remote location. Both are designed for standard rack mounting. The hydraulic assembly is connected by quick-disconnect fittings.

COMPATIBILITY: The LEAKMETER is compatible with all common hydraulic fluids and fuels. Because both assemblies are isolated from the test environment, the item under test may be subjected to shock, vibration, or high temperatures. **TEST PRESSURES:** Accommodates test pressures to 5000 psi. **OPTIONAL READOUT:** Jacks are provided for recording or other readout. **PROVEN:** In use by leading manufacturers of high performance hydraulic equipment.

Front Panel — Hydraulic Transducer Assembly

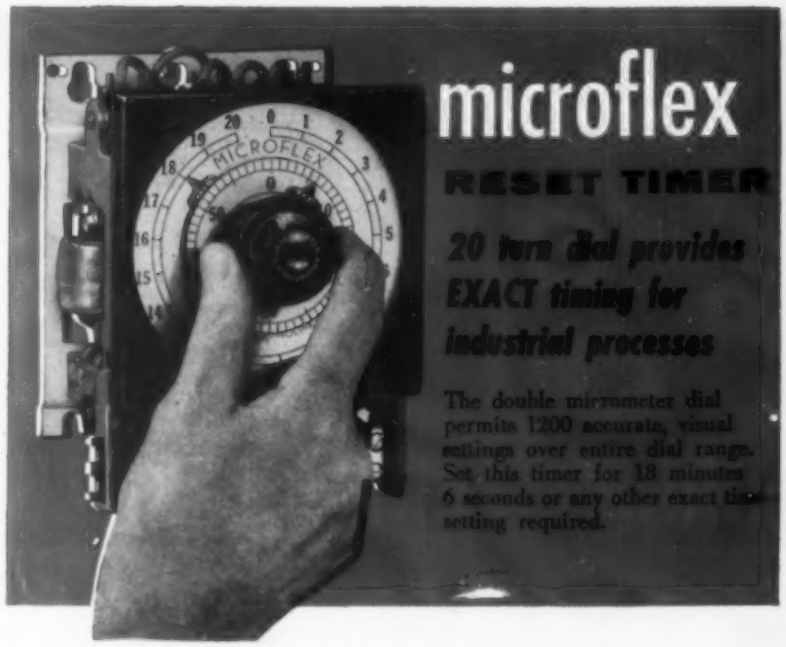
For COMPLETE INFORMATION: Write, wire, or phone:

CONVAIR INSTRUMENTS / CONVAIR, A DIVISION OF GENERAL DYNAMICS CORPORATION

CI

3595 Frontier Street, San Diego, California
ACademy 3-1614

ELECTROMECHANICAL AND MECHANICAL INSTRUMENTS; AC AND DC MEASURING DEVICES, TRANSDUCERS.


microflex
RESET TIMER
20 turn dial provides EXACT timing for industrial processes
The double micrometer dial permits 1200 accurate, visual settings over entire dial range. Set this timer for 18 minutes 6 seconds or any other exact time setting required.

Savings

- Large 15 ampere contacts eliminate additional load relays.
- Stop down time with plug-in components for fast timer replacement.

Flexibility

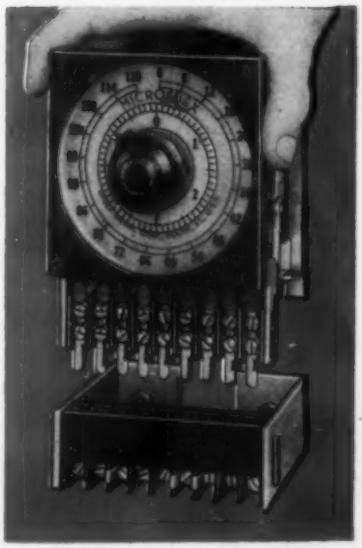
- Easy to set dial whether short or long timing.
- Choice of 9 actions available for each of 3 contacts. Select operation required for your circuit.

Accuracy

- Set dial to exact time required. No guessing at numbers.
- Accurate repeatability insures uniform production.

Reliability

- Proven reliability in thousands of industrial processes for more than 25 years.



Install timer in seconds with optional plug-in feature.

EAGLE SIGNAL COMPANY
Industrial Timers Division, Dept. AH-959
MOLINE, ILLINOIS

Please send FREE Bulletin 110 containing complete data on Microflex Reset Timers.

NAME AND TITLE

COMPANY

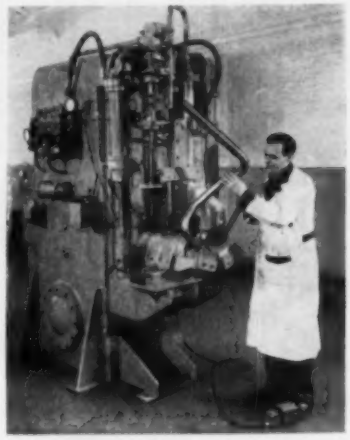
ADDRESS

CITY ZONE STATE

BRIEFS

ube sizes of 2" O.D. by 0.083" wall.

Retained from previous models is the 10-station angle-of-bend selector that automatically controls



the depth of the ram stroke and its resulting bend angle.

The automatic resetting feature eliminates cycling through idle stations, increasing production.

Wing dies, hydraulically cushioned by twin cylinders and mounted vertically on the sides of the press, assure smooth, quality bending results.

Greer establishes International Symposiums for Hydraulics

Announcement was made by Edward M. Greer, president of Greer Hydraulics, Inc., Jamaica, N. Y., of a series of international symposiums scheduled to start this year.

Based on the general subject of the application of accumulators in hydraulic systems, the meetings will get underway Sept. 11-12 in Paris, France, under the auspices of Olaer France.

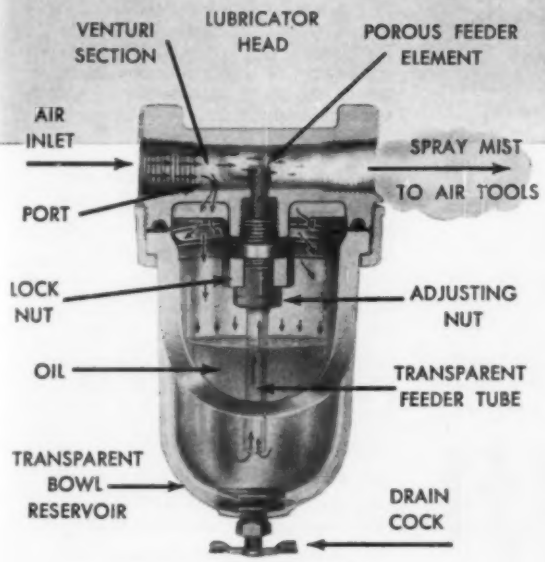
Plans have been made for a similar symposium for Sept., 1960 in Stuttgart, Germany, and in Sept., 1961 in London. The 1962 meeting, sponsored by Greer, will include a week's tour of the hydraulics industry, from New York to Los Angeles. □□□

Continued on page 38

Arrow AIRLINE SPRAY MIST LUBRICATORS

Supply a fine Spray Mist Lubricant by the most efficient and effective two-stage method!

By PRE-DIVIDING or breaking up the oil in the first stage before completely atomizing the Lubricant in the second stage. The Spray Mist is then carried along throughout the entire pattern of the air stream to lubricate the working parts of air-powered tools, cylinders, valves and other pneumatic devices.



Illustrates the operation of the ARROW "patented" two-stage, tamper- proof Lubricator.

Compressed air from the drop line enters the Lubricator to Venturi section of the Lubricator Head where the porous feeder element protrudes into the Air Stream.

Small ports in front of the porous feeder permits air pressure transfer on the oil surface in the bowl reservoir. The pressure differential created by the Venturi forces the oil to rise in the transparent feeder tube, into and through the porous feeder element which PRE-DIVIDES the Lubricant in this first stage, into minute particles of oil.

The Lubricant now finely divided and saturating the porous feeder element, is now easily and most efficiently atomized from the feeder element, at this second stage, by the action of the Venturi on the compressed air passing through the Lubricator Head.

The two-stage method incorporated in the ARROW LUBRICATOR insures a fine spray mist for wider ranges of AIR FLOWS at lower pressure drops.

Simplicity of design with only one tamper-proof adjustment provides for most efficient, low-cost operation.

PROTECT YOUR PNEUMATIC EQUIPMENT

Complete Conditioning and Control of Compressed Air Prolongs Service Life, Reduces Maintenance and Repair of Air-Powered Tools, Cylinders, Valves and Other Pneumatic Equipment.

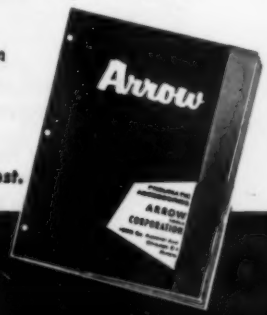
the most Efficient and Complete AUTOPNEUMATIC CONTROL By Arrow

A choice of fine or coarse grade porous Bronze Feeder Wick as required for lubricant or application. A choice of Hand Filling Type Lubricator or a Pressure Filling Type with Button Head Fitting or the ARROW . . . New Fully Automatic Filling Type which with the Automatic Drain Trap makes Autopneumatic Control completely automatic, eliminating all hand or manual servicing.

Many Types and Models of Single Units and Units in Combination Assemblies to Meet Specific Requirements.

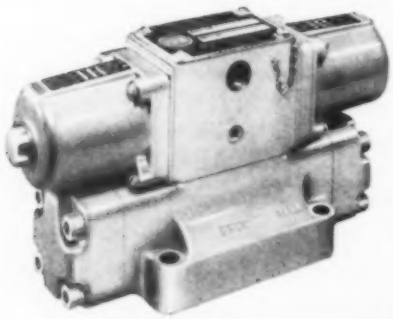
PIPE LINE SIZES—
¼"—⅜"—½"—¾" and 1" N.P.T.

Catalog and Engineering Data Sent on Request.



ARROW TOOLS, INC. 1934 S. KOSTNER AVE. CHICAGO 23, ILL.

NEW H-P-M ¾" PILOT-OPERATED SOLENOID CONTROLLED 4-WAY VALVES



3000 psi, 20 gpm

Smoother Acting, Longer Lasting, Oil-Immersed Solenoids

THE PRICE IS IMPORTANT!

►H-P-M's new pilot-operated valves are completely interchangeable with industry standards. Proved in use on fast cycle production machines. Oil-immersed solenoids, standard at H-P-M, lessen shock—are smooth and quiet in action — less wear — last longer. H-P-Ms cost only a few dollars more than conventional air-gap types.

AVAILABLE FROM STOCK FOR IMMEDIATE DELIVERY

Write for complete information, specifications and performance data.

THE HYDRAULIC PRESS MFG. COMPANY

A Division of Koehring Company
Mount Gilead, Ohio, U.S.A.

Circle **79** *on Time-Saver Card*

MILLER FLUID POWER, TRU-SEAL DIVISIONS MOVE TO NEW $2.3 MILLION HOME

Dedication ceremonies were held July 26 for the new $2.3 million Flick-Reedy Corp. plant in Bensenville, Ill.

The two corporation divisions are Miller Fluid Power, makers of air and hydraulic cylinders, boosters, and accumulators, and Tru-Seal, makers of Teflon seals.

Preceding the ceremonies were four days of sales meetings, conferences, TV shows, parties, guided tours, and open houses.

Located at York and Thorndale Roads, the new building is just west of Chicago's O'Hare Airport.

• **Heat pump largest** — The heat pump is the largest installation of its type in the world. It can extract sufficient heat from even sub-freezing air for heating the large plant.

During the summer, the cycle is reversed for air-conditioning.

• **Many other features** — A built-in swimming pool with complete recreational facilities; two man-made lagoons on the plant site to help solve the water conservation problem; a separate disposal plant; revolutionary roof construction and insulation which eliminates partitions, placing the weight of the entire building on rigid frames, and a modern, practical electrical system, featuring underground ducts and a module lighting system that permits changes in intensity from 20-120 candlepower.

PRESIDENT FRANK FLICK (left) discusses the air-source heat pump installation, with Roy C. Ingersoll, chairman of Borg-Warner Corp., whose company designed and built the equipment.

THIS FULLY-EQUIPPED swimming pool and adjoining recreational facilities combine pleasure with cost-saving industrial advantages.

Built at savings—Average cost per square foot for Flick-Reedy's new home has been estimated at $10, including the features of the swimming pool, lagoons, and auditoriums.

The swimming pool, measuring 40x60 ft., will serve as a continuing research vehicle for a new chemical and water filter Flick-Reedy is developing.

Since piping water from Bensenville would have cost $280,000, including expenses for a water storage tank, the pool and lagoons' cost represents a sizeable savings. □□□

More Briefs on page 42

FLICK-REEDY'S NEW HOME is this $2.3 million building.

IT'S ICE-SLICK

Won't Stick at 30° Below

Try C/R K-400 Cups for Smoother Power Cycles

Any time you face the problem of reducing cylinder cup breakaway or sliding friction, chattering or freezing, come see us. We're reasonably certain that Chicago Rawhide's Sirvis Leather K-400 cups can help you. Their specialty is easy sliding — particularly in vacuum cylinders at sub-zero temperatures and in pneumatic cylinders at ambient temperatures and low pressures. Tests show a 50% reduction in breakaway and sliding friction over standard leather cups at ambient temperatures . . . and these K-400 cups are functioning beautifully in applications at -30° F. In another test, C/R Sirvis K-400 cups were run well over one million cycles at 20" of vacuum with negligible leakage and wear.

So if you are trying to design a new, smooth-working, low-friction pneumatic cylinder — or take the bugs out of an old one — jot down C/R K-400 cups and call us.

CHICAGO RAWHIDE MANUFACTURING COMPANY

SIRVIS DIVISION, 1203 ELSTON AVENUE • CHICAGO 22, ILLINOIS

Offices in 55 principal cities. See your telephone book.

In Canada: Chicago Rawhide Mfg. Co. of Canada, Ltd., Brantford, Ontario

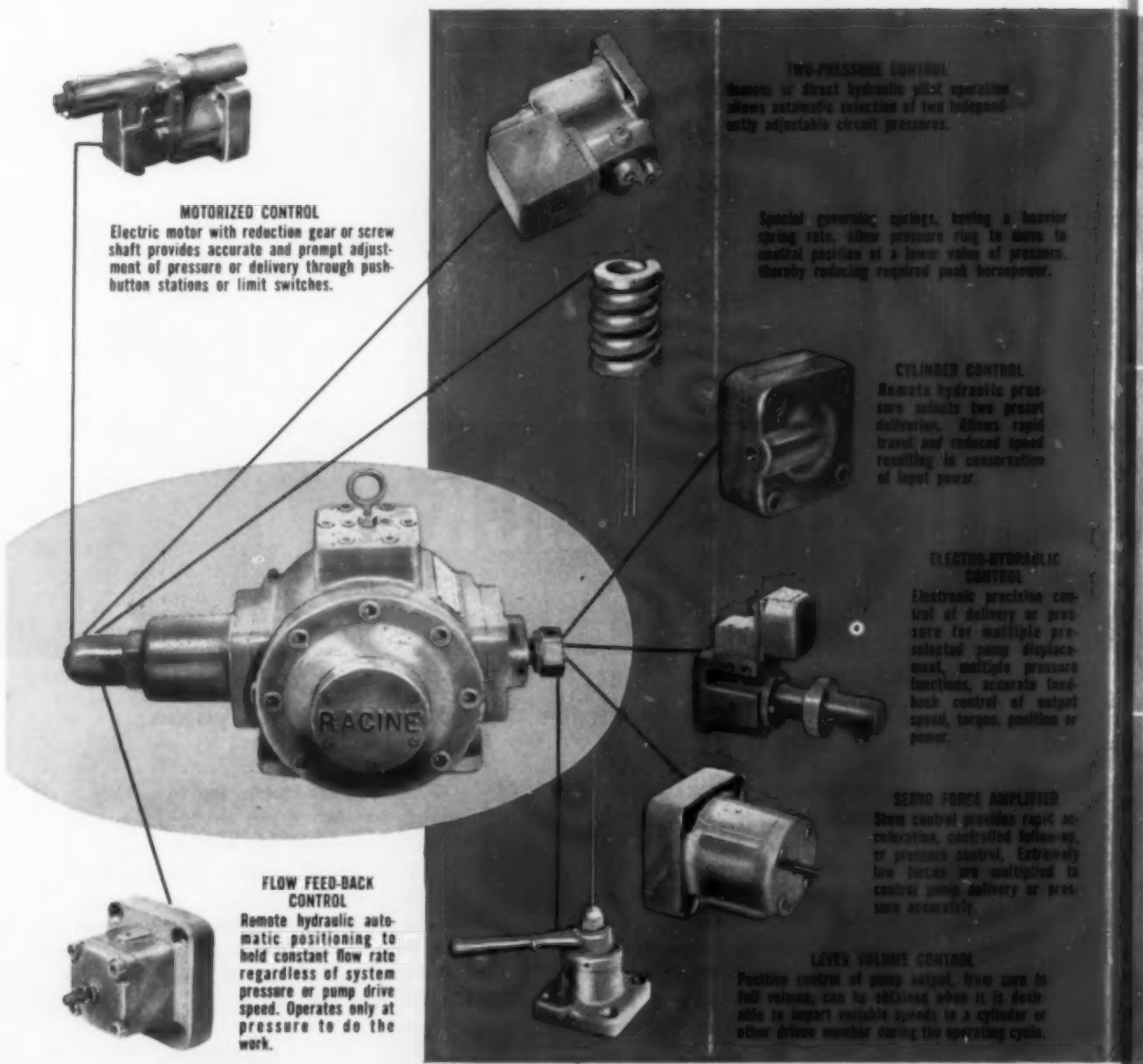
Export Sales: Geon International Corp., Great Neck, New York

C/R PRODUCTS: C/R Shaft & End Face Seals • Sirvene (synthetic rubber) molded pliable parts • C/R Non-metallic gears

C/R

RACINE-SECO

Variable Volume Vane Type **PUMP CONTROLS . . .**


MOTORIZED CONTROL
Electric motor with reduction gear or screw shaft provides accurate and prompt adjustment of pressure or delivery through push-button stations or limit switches.
TWO-PRESSURE CONTROL
Special governing springs, having a heavier spring rate, allow pressure ring to move to neutral position at a lower value of pressure, thereby reducing required peak horsepower.
CYLINDER CONTROL
Remote hydraulic pressure selects two preset deliveries. Allows rapid travel and reduced speed resulting in conservation of input power.
ELECTRO-HYDRAULIC CONTROL
Electronic precision control of delivery or pressure for multiple pre-selected pump displacement, multiple pressure functions, accurate feed-back control of output speed, torque, position or power.
SERVO FORCE AMPLIFIED
Servo control provides rapid acceleration, controlled follow-up, or pressure control. Extremely low forces are multiplied to control pump delivery or pressure accurately.
LEVER VOLUME CONTROL
Positive control of pump output, from zero to full volume, can be obtained when it is desirable to impart variable speeds to a cylinder or other driven member during the operating cycle.
FLOW FEED-BACK CONTROL
Remote hydraulic automatic positioning to hold constant flow rate regardless of system pressure or pump drive speed. Operates only at pressure to do the work.
RACINE

Write for Catalog No. 59-A describing RACINE-SECO complete line of Hydraulic Equipment.

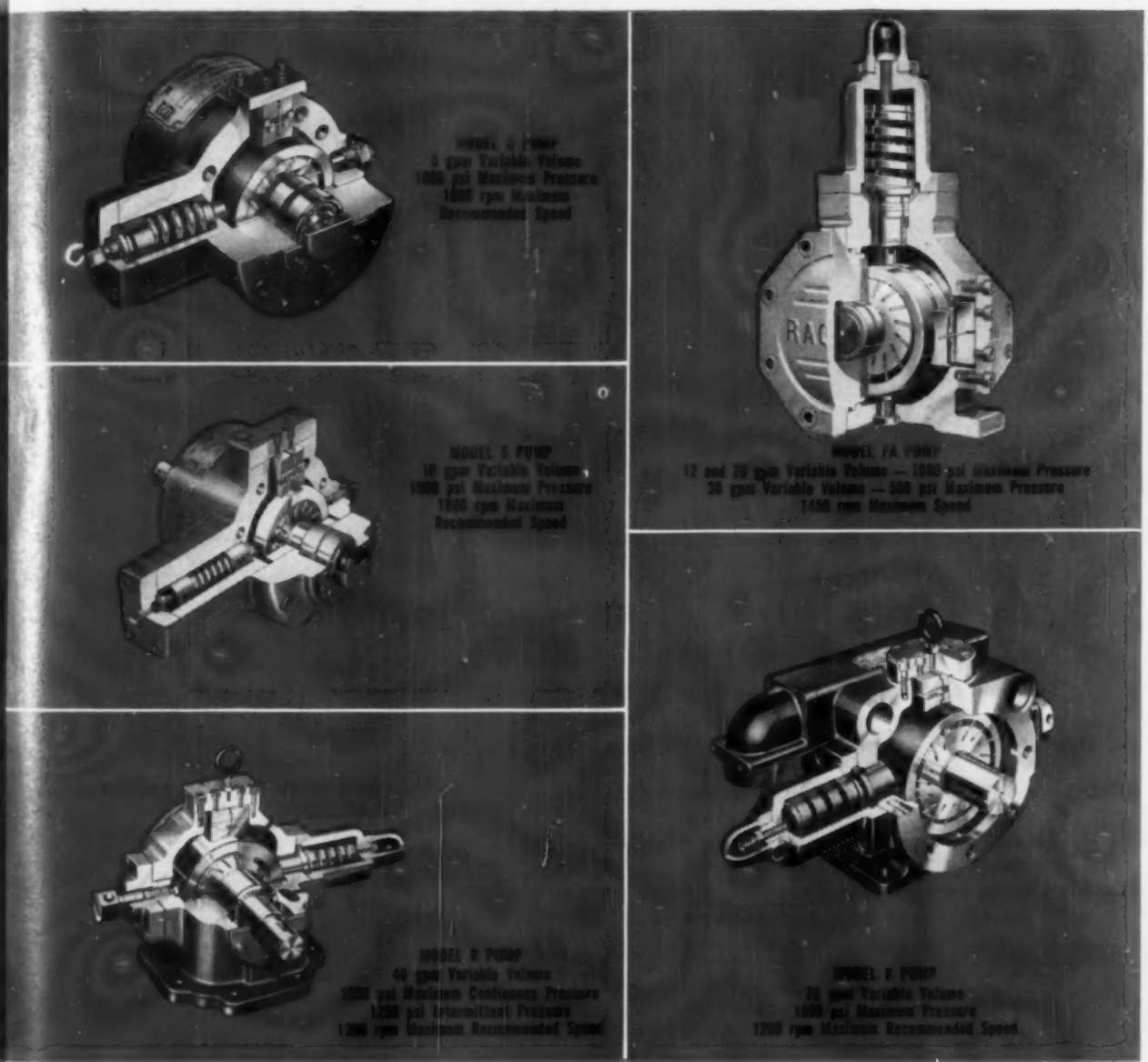
RACINE SECO

RACINE HYDRAULICS & MACHINERY, INC.

RACINE, WISCONSIN

One Source — One Responsibility for all your hydraulic needs

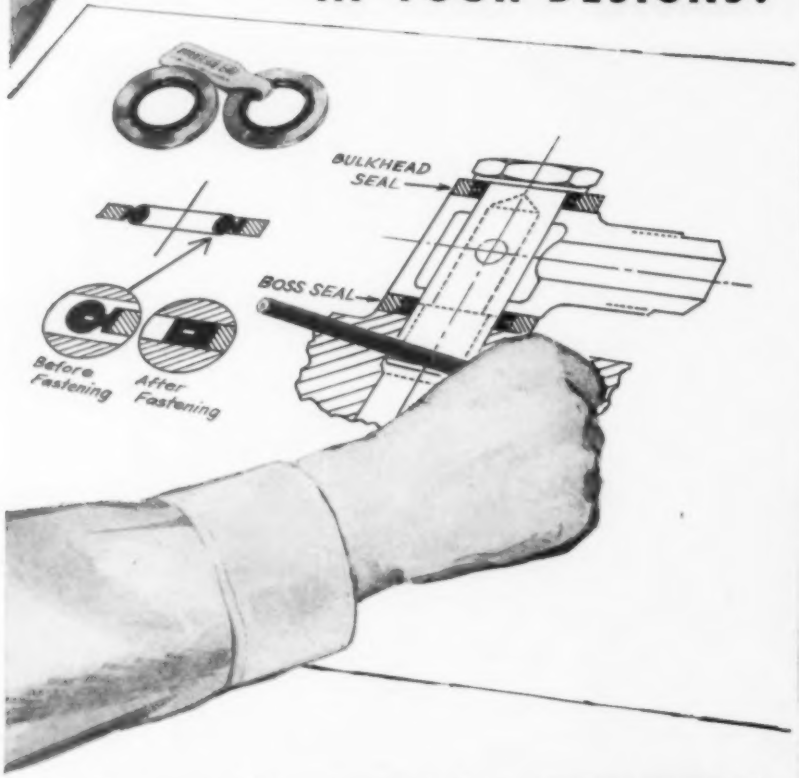
. . . FOR THESE RACINE PUMPS



RACINE-SECO Variable Volume Hydraulic Pumps automatically deliver *only* the amount of oil needed to properly operate the circuit. There is no waste of "pressure oil" — all the energy is put to useful work, thus assuring extremely high circuit efficiency at low operation cost.

Through the use of the proper pump control shown at left, adjustment for maximum pump displacement for exact circuit requirements can be obtained. High and low pressure from the same pump and other variations are all possible through the use of proper standard controls. Numerous pump mountings are available and include J.I.C. sub-plate design.

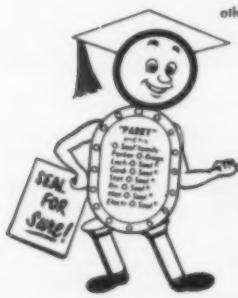
NOW YOU *CAN* USE BANJO FITTINGS IN YOUR DESIGNS!



Some years ago, this famous space-saving fitting lost favor with engineers due to the difficulty of sealing them properly. But *now*, Banj-O-Seals* make the use of banjo fittings popular again! Banj-O-Seals* are a development of Parker Seal Company, using the famed one-piece Stat-O-Seal* design. They make it easy to seal "banjo" fittings . . . they are easy-to-install, easy to remove and *they provide no-leakage sealing*. Proof of the pudding? . . . Banj-O-Seals are retrofit on nearly every leading airline!

write for free catalog and literature.

Stat-O-Seals*, also seal bolts, studs and other fasteners . . . self-centering, re-useable, easy to install.



. . . another example of "seal-for-sure" designs by . . .

Parker SEAL COMPANY
Culver City, California and Cleveland, Ohio
A DIVISION OF PARKER-HANNIFIN CORPORATION

* Trade Mark Registered

Circle **122** on Time-Saver Card

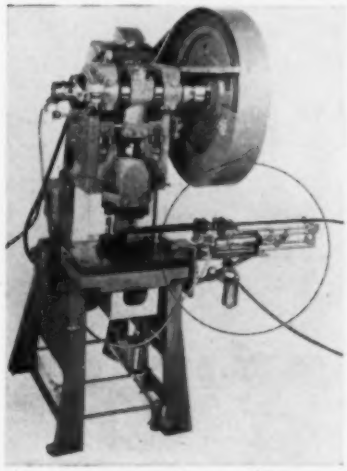
BRIEFS

Micro Valve Control For Portable Feed Unit

A portable, air-operated stock feed now converts hand-fed press jobs to swift automatic feeding, by using the Micro Valve control unit which can be mounted in minutes without links or rods.

This versatile press feed line is made by the Industrial Sales Division of Cleveland Pneumatic Industries, Inc., Skokie, Ill.

Entirely air operated, the press feed uses no solenoids, eliminating



electrical connections. Air consumption, is minimized because power can be regulated for individual job requirements by a simple adjustment.

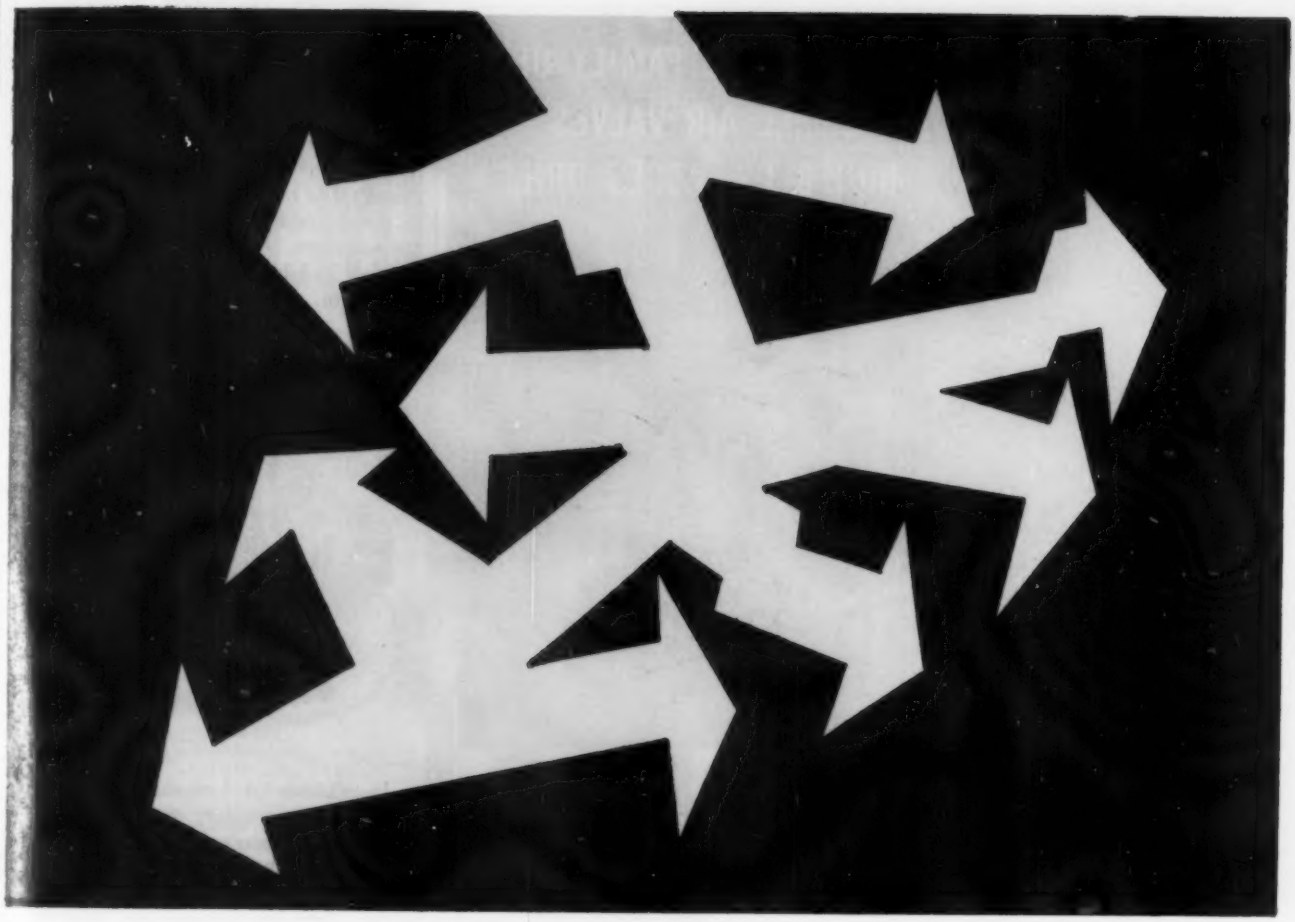
Stock grippers are opened for instant loading and aligning of stock through the guide by means of the Micro Valve. Stroke length is readily adjusted on built-in feed control stop and feed tolerances may be held as closely as ±0.002 in.

The stock feed comes in four standard sizes, and stock lengths are to 8 inches. □□□

Hydraulic Power Checks Cut Pipe

The 1959 Continental Rotary Pipe and Tube Cut-Off Machines come equipped with hydraulic power checks that speed up cutting of pipes and tubes.

Continued on page 44



DIRECTIONAL CONTROL absolute control

of movement in any direction can

only be achieved by hydraulic power.

Ask us at KEELAVITE we know how

We at Keelavite are a team of experts engaged SOLELY in the application of hydraulic power

KEELAVITE

Hydraulics

KEELAVITE HYDRAULICS LTD • ALLESLEY • COVENTRY • ENGLAND • TEL. MERIDEN 441

NOW
A COMPLETE FAMILY OF SMALL AIR VALVES, MANIFOLDS, ACCESSORIES
Double solenoid, momentary contact (detented)
Single solenoid, spring return
Manifolds—four styles

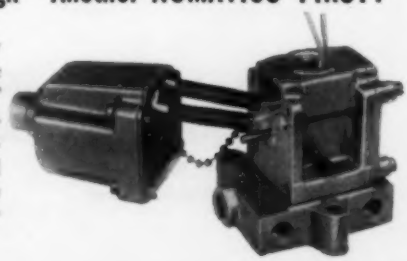
NUMATICS' New SA Junior Series

You've found it! . . . the answer to *all* your small air valve requirements. It's the new *SA Junior* Series . . . Numatics' small, precision-built, heavy duty family of valves and manifolds. Two valve types (above), many model varieties . . . three different sub-plates . . . three operator options and four styles of manifolds to provide application versatility unlimited.

SA Junior, what's more, gives you *quality* throughout . . . Numatics' famed patented lapped spool-floating sleeve action . . . corrosion-resistant aluminum body . . . continuously rated, heavy duty solenoids . . . J. I. C. conformance . . . all this plus a ruggedness and reliability to handle 60% of all your air jobs at an average 40% reduction in air valve costs. Send for a catalog today!

"Solenoid Capsule" Design—Another NUMATICS' FIRST!

Typical of SA Junior quality and design ingenuity is the unique, new "Solenoid Capsule" . . . a Numatics' *exclusive*. Solenoid and cover are a self-contained, J. I. C. approved assembly which eliminates loose parts when the solenoid cover is removed.

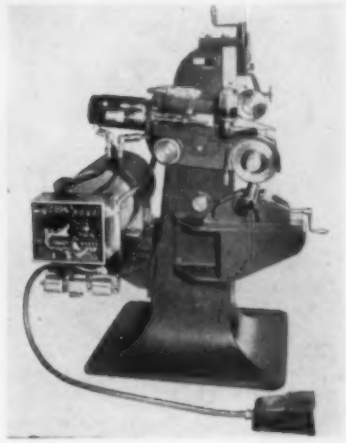


NUMATICS, Inc.
HIGHLAND, MICHIGAN

Circle **115** on Time-Saver Card

BRIEFS

Designed for users whose needs range from smallest and lightest gauge tubes to heavy-walled pipes in diameters up to 12¾-in. o.d., the machines offer increased production and lower costs for each cut length.



Installation of hydraulic components was necessary to meet the demand for increased speed and precision control. The hydraulic power check achieves a smooth cutting stroke by keeping the exact, uniformly regulated cutting pressure on the wheel and work.

Manufacturers are the Continental Machine Co. of Chicago. □□□

Hydraulics Give Crane Versatility

Hydraulic features are involved in the multi-use operation of two self-propelled cranes introduced

by Austin-Western Works of Baldwin-Lima-Hamilton Corp., Philadelphia.

The Model-110 has four basic options, one having a hydraulically operated telescoping boom

Continued on page 46

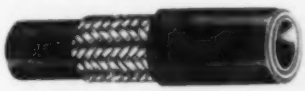
For every industrial and automotive application... the complete line of non-skive

ALEMITE SURGEPRUF®

REUSABLE COUPLINGS AND HYDRAULIC HOSE

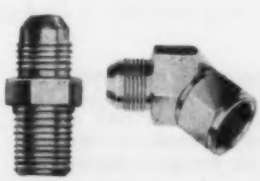
Couplings. Made of high-strength steel, dichromate plated. "Double-wedge grip" forces coupling threads through rubber cover . . . grips either single- or double-wire braid firmly. Saves both time and labor!

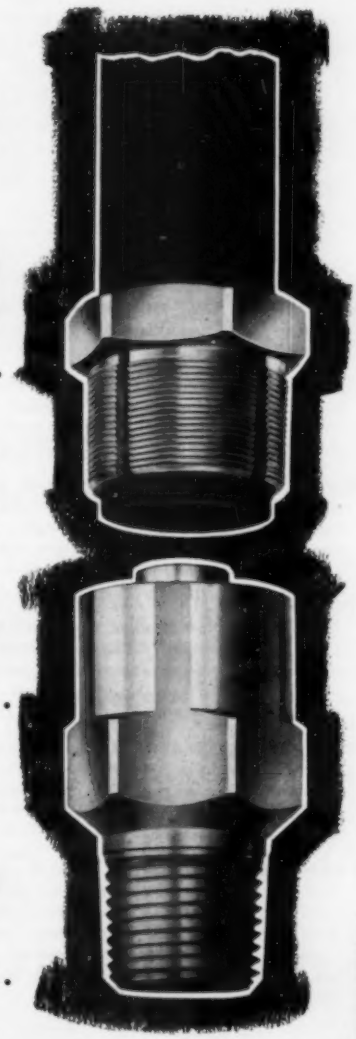
Medium-high and high-pressure hose and reusable couplings. Single and double wire braid hose. Non-skive feature assures fast, easy assemblies. Seamless inner tube of Buna-N rubber and Neoprene outer cover. Resists abrasion, weather and oil. No special tools required.



New Low-Pressure "Shur-Lock" Hose. For use on fuel, filter, oil, air and vacuum gauge lines. Rugged, precision-matched couplings. Leak-proof grip.

Adapters and swivel adapters. Full range of sizes in J.I.C. and other threads. One-piece adapters—and swivel union adapters to simplify assembly and avoid twisting strain in cramped quarters.





Distributed nationally for immediate delivery, Alemite Surgepruf Hose and Couplings are preferred for either fast, easy on-the-job replacement or quality original equipment use. For temperature operating range of −40° to +275°F. Couplings are reusable. Complete range of sizes in hose, couplings, adapters and swivel adapters.

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BRIEFS

extending from 7 to 13 feet in front of the bumper. Cable hoist, boom topping, and telescoping are hydraulically controlled from the operator's seat.

A completely hydraulic swing mechanism is optional. In this version, the maneuverable three-wheel chassis has the added flexibility of a boom that (1) telescopes to 13 feet; (2) rotates hydraulically 220°; (3) positions from horizontal to 50° angle by fluid power, and (4) hoists the lifting cable hydraulically.

Manual extensions push the working radius to 18 feet, seven inches.

Also introduced was the Model-410 which operates in the 10-ton range. Telescoping, rotating boom, hook travel, and topping are operated and actuated by fluid power. The chassis has four-wheel hydraulic power steering, hydraulically operated outriggers, and torque converter drive.

Total boom reach is 25 feet, with optional manual extensions to 47 feet. The boom tilts hydraulically to an angle of 60°. □□□

Continued on page 50

BRIEF NOTES

HUGH FEDERER IS NEW CHAIRMAN . . . of the NFPA's Management Services Board for this year. Vice chairman and secretary will be Neil Whitney of Cessna. Federer is president of Teer-Wickwire & Co.

HOW TO USE LIMIT SWITCHES . . . a 10-page booklet has been reprinted by Micro Switch. Published by the National Electrical Manufacturers Association, this literature includes suggestions for proper use of industrial limit switches.

HYDRAULICS ON HALIBUT . . . Pint-sized electro-hydraulic servo valves will be used to position the giant rudder and diving planes aboard the Halibut, newest atom sub. Supplied by Bendix-Pacific, the valves direct the sub's hydraulic system, operating control cylinders on command from the ship's flight center.

IT'S NOW POSSIBLE . . . to make automatic corrosion measurements. The Model L-2 servo-controlled Corrosometer is capable of detecting as little as 1 millionth of an inch corrosion. It automatically tracks corrosion as it occurs, providing a permanent record of total thickness corroded. Manufacturers: Crest Instrument Division, Magna Products, Inc., Santa Fe Springs, Calif.

A MISSILE TEST STAND SYMPOSIUM . . . was hosted by The Rucker Co. for engineers from Aerojet-General Corp. and Lockheed Missile and Space Division. Purpose was to promote an exchange of ideas regarding qualifications of a modern test stand for testing hydraulic missile components.

NEW CONTROL FOR VIBRATION . . . A new type pressure accumulator unit, or surge chamber, has been perfected to eliminate vibration headaches in fluid power systems. Designed by The Commonwealth Engineering Co., the accumulator has an adjustable volumetric capacity. A simple handwheel control varies the capacities of both accumulator and system. Product is patented and available for license.

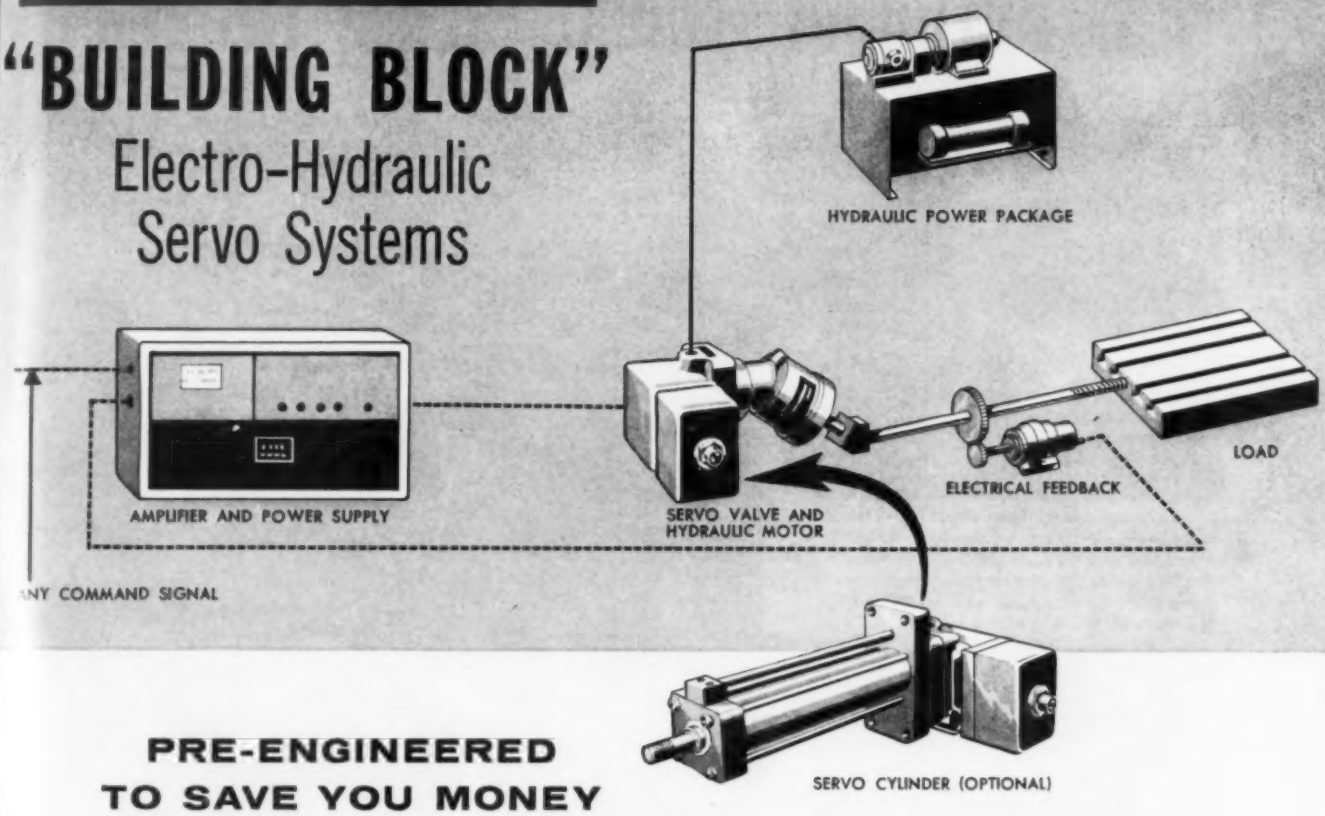
BUSINESS BRIEFS

CHIKSAN PURCHASES HAMER VALVES . . . in a recent transaction. Established in 1928, Hamer Valves, Inc., makes plug valves, gate valves, and line blind valves marketed principally in the petroleum and chemical process industries. Chiksan Co. is a subsidiary of Food Machinery and Chemical Corp.

ORONITE CREATES NEW DEPARTMENT . . . as part of a major expansion and reshaping of its hydraulic fluid development activities. The new Commercial Development Dept. will encompass both market development and market research. Named general manager was Dr. R. I. Stirton, formerly manager of the company's product development dept.

A NEW CONCEPT

"BUILDING BLOCK"
Electro-Hydraulic Servo Systems



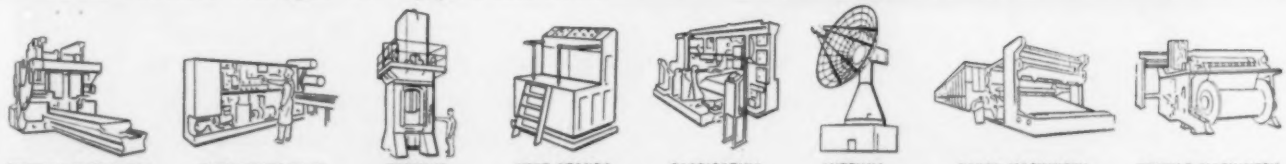
PRE-ENGINEERED TO SAVE YOU MONEY

Standard hydraulic and electrical components are now pre-engineered into a series of complete and dependable Electro-Hydraulic Servo Systems. Vickers has the most extensive line of individual "building block" components available for such systems. Inherent "trim flexibility" makes possible systems which will satisfy a very wide range of application . . . at only a fraction of the cost usually incurred in specially engineered systems. A very substantial saving in lead time is now possible.

Vickers "Building Block" Closed Loop Servo Systems have proved their merit on machine tools, fabricating machines and processing equipment. The amplifier is precisely matched to the servo valve torque motor. The work load requirement is continuously monitored by electrical feedback devices to insure that directions (command signals) are accurately followed at all times.

Positional accuracy of better than .001 is obtainable with a hydraulic motor and lead screw. In many position applications, cylinders can be used with similar accuracies. Velocity can be maintained within one or two rpm. In addition to position and velocity controls now in service, constant horsepower and constant tension systems soon will be available. Any command signal may be used with these systems . . . from a simple potentiometer to complete numerical control. For further information, ask for Engneering Bulletin No. 59-75.

wide range of applications



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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

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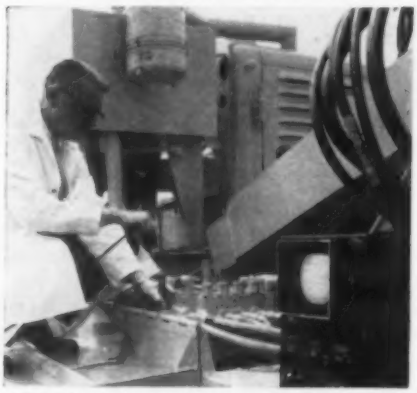
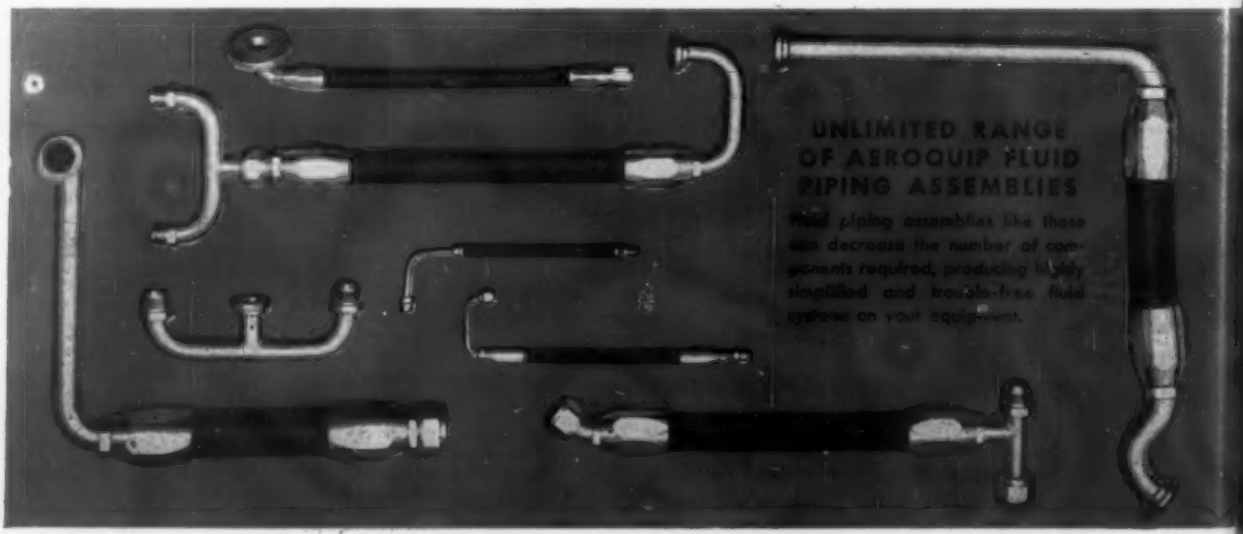
How Aeroquip's Fluid Piping Program

Aeroquip sales engineers direct the service teams in the field. One is shown here discussing a problem with the manufacturer's representative. The Aeroquip sales engineer has followed equipment development and is thoroughly familiar with the fluid piping system.



Aeroquip service engineers are trained trouble-shooters who can test a fluid system and locate quickly the source of a problem.

The Aeroquip designed and built Hydrauliscope is being used by a service engineer to analyze fluid systems in operation. It presents electronic data that often shows where unexpected peak pressures result under field conditions.



Helps You Solve Field Service Problems

SKILLED AEROQUIP FIELD SERVICE SPECIALISTS ARE AVAILABLE TO EQUIPMENT MANUFACTURERS WHO UTILIZE AEROQUIP'S FULL RANGE OF FLUID PIPING SERVICES

- DESIGN
- PROTOTYPE
- PRODUCTION
- FIELD SERVICE
- SERVICE PARTS

Sound engineering plus experience gained in working with your engineering and production people in the design, prototype and assembly line stages, enables us to accept full responsibility for the performance of Aeroquip products on your equipment. Experienced Aeroquip field service engineers are available to you to assist in providing *after sale* service when needed.

This field service is one of the most unusual advantages offered in Aeroquip's fluid piping program. It is one of the final steps in a complete fluid piping program which includes assistance in original design, prototype development, production planning and even includes extensive assistance in service parts programming.

Start, today, to simplify your fluid piping problems. Mail the coupon below for complete information.

Check list of hose installations and thorough inspection of the entire fluid piping system is routine for the Aeroquip field service team.

Soundly engineered equipment backed by quality manufacture assures the user maximum performance in the field. Aeroquip is proud of its association with many leading equipment producers.

Aeroquip

REG. TRADEMARK

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INDUSTRIAL DIVISION, VAN WERT, OHIO • WESTERN DIVISION, BURBANK, CALIFORNIA

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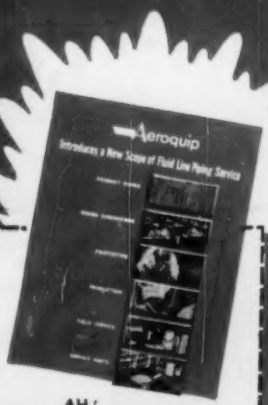

Special Literature Available

Aeroquip Corporation, Jackson, Michigan

☐ Please send me a copy of Bulletin 614 explaining your complete service of fluid system design and performance.

☐ Please have an Aeroquip Sales Engineer call on me to discuss this service.

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This revolutionary Carter Rotary Torque Actuator gives engineers a whole NEW field of design opportunities! Up to 370° of rotary fluid power as standard... Safe, powerful torque from air, oil, gas or water power. Zero leakage! Built in cushions! Infinite positioning flexibility! Thousands of applications!

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0-280°
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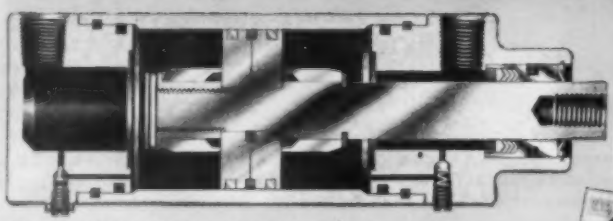
as standard
PNEUMATIC or HYDRAULIC

Patents Pending

Send for 12-page Bulletin with complete engineering data.

CARTER offers unlimited cost-cutting design opportunities through industry's only COMPLETE LINE of LINEAR and ROTARY fluid power actuators!



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Complete bound file with ordering details for: Air Cylinders, 750 PSI Hydraulic, 1500 PSI Hydraulic, Clamp Cylinders, Air Valves, Built-in Valve Types. Complete with parts data, specifications and prices. Send today!

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1. Space saving designs! Light weight!
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BRIEFS

Engineers Plan To Attend NCIH

A tentative program has been drawn up for the 15th National Conference on Industrial Hydraulics. This year's meeting is scheduled for Oct. 22-23 in the Hotel Sherman, Chicago.

Complete abstracts of the conference papers, plus the winning entries in the annual Fluid Power Prize Paper Contest, sponsored by APPLIED HYDRAULICS & PNEUMATICS, will be featured in the October issue of this magazine.

Engineers in this country and abroad are making reservations for the Chicago meeting.

Details of the program as scheduled now are:

General Session

1. Paper on principles of purchasing and replacing industrial equipment by Dr. G. J. Matchett.
2. "Economics of Obsolescence" by a representative of General Electric Co.

Components and Accessories

1. "Testing Hydraulic Circuits for Preventive Maintenance and Troubleshooting" by John S. Schroeder, Schroeder Bros. Corp.
2. "Central Hydraulic System for Agricultural Machines" by Dr. A. H. Mark, Massey-Ferguson, Inc., Detroit.

Pneumatics

1. Paper on assembly equipment by Ward Beale, General Motors Process Development.
2. Panel discussion on "Good Shop Air Systems."

Pumps

1. "Servo Control Pumps on Roll Forming" by Robert L. Filmore, Minneapolis-Honeywell Regulator Co., Minneapolis.
2. "Variable Volume Pump Control" by Charles Breitsprecher, Racine Hydraulics and Machinery, Inc.

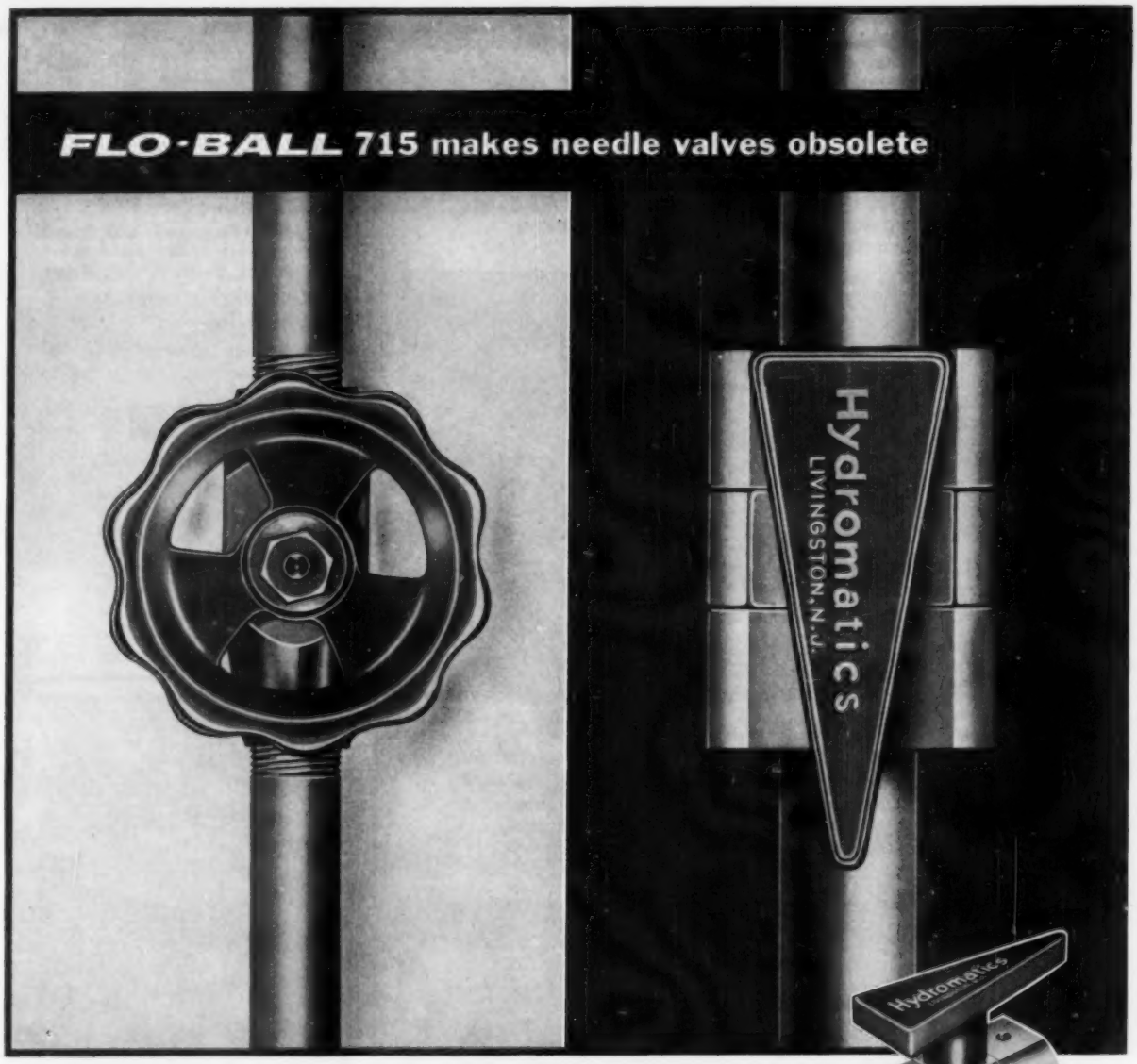
Machine Tools

1. "Methods for Instrumenting Electro-Hydraulic Servo Systems" by Ray G. Spencer and John Binsfeld, Vickers Incorporated.
2. "Designing Components for Industrial Electro-Hydraulic Servo-Mechanisms" by Dr. C. B. Sung and J. R. Farron, Bendix Research Laboratories, Detroit.

Materials Forming Machinery

1. "Power Spinning" by Garrett Vis-

Continued on page 52



WHICH VALVE IS OPEN?

They both are . . . but only the Hydromatics ***FLO•BALL 715,*** on the right, shows its position at a glance! A fast **quarter** turn moves it from open to closed position—instant action at flow pressures up to 3,000 psi with just 4 inch-pound torque. The ***FLO•BALL***'s exclusive straight-thru design has 100% flow efficiency—more than double the flow of needle valves!

Ideal for leakproof control of air, vacuum, steam, water, fuels, oils, kerosene, alcohol, etc., the ***FLO•BALL*** features zero leakage, universal mounting, removable flanges, and all stainless steel construction.

Write today for a complete catalog describing this valve and others for corrosive and cryogenic media. Also special designs for throttling flow control.

The *FLO•BALL* costs no more than old fashioned screw-type valves!

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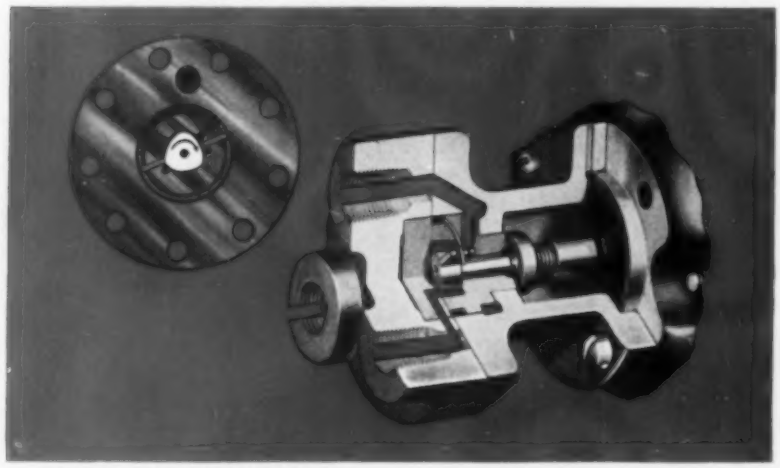
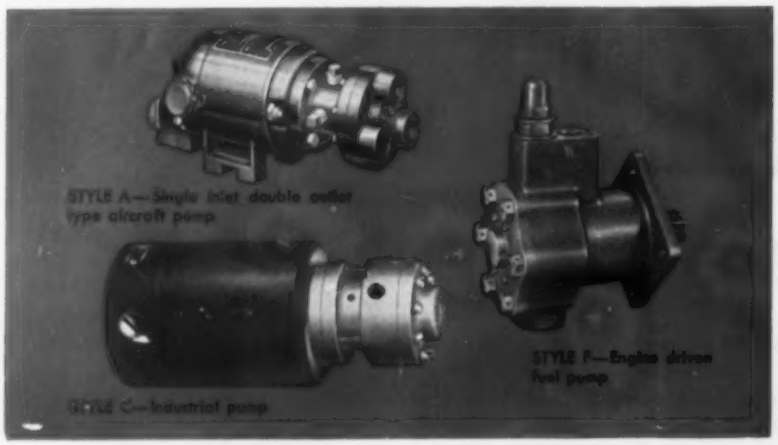
WELDON / FLUID METERING PUMPS

Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.



IT'S SO SIMPLE!

The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.



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BRIEFS

ser, Midwest Automation, Inc., Minneapolis.
2. "Impact Forming" by J. B. Ottestad, Convair.
3. "Brains (Electronic) and Brawn (Hydraulics) Without Servo Valves" by Walter P. Hill, Walter P. Hill Co.

Mobile Equipment

1. "Hydrostatic Transmissions for Mobile Equipment" by Paul Mortenson, Vickers Incorporated.
2. "Higher Pressure Hydraulic Systems" by Wes Masters, Dynex, Inc., Milwaukee.

Servomechanisms

1. "Application of Servo Valves with Flow Feedback" by Eugene Bahniuk, Pesco Products Div., Borg-Warner Corp.
2. "Tape Command Electro-Hydraulic Machine Tool Control" by Peter Herzl, Sperry Gyroscope Co., Ltd., Montreal.

HEIGHTS TO 100 FEET can be reached by workers using this completely hydraulically operated aerial lift. These mobile units mount on a standard truck chassis. Boom is a 2-stage telescoping design which rapidly erects to the desired position. Outriggers are supplied for added stability. Made by Truck Equipment Co., Denver, the lift has full rotation, raises 75° from horizontal and uses either PTO or separate engine to power the hydraulic system.

Space Hydraulics

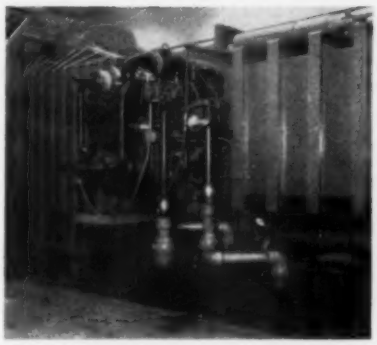
1. "Acceleration Switching Hydraulic Servos in Navy Guided Missiles" by W. Seamone, Applied Physics Laboratory, Silver Spring, Md.
2. "Gyroscopic Mass Flowmeter" by Dr. Wilfred Roth, Roth Laboratories for Physical Research, Hartford, Conn.

Continued on page 54

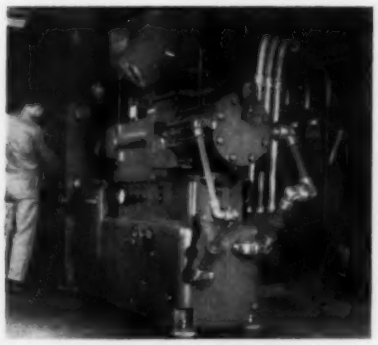
ON EQUIPMENT LINES ■

CHIKSAN SWIVEL JOINTS

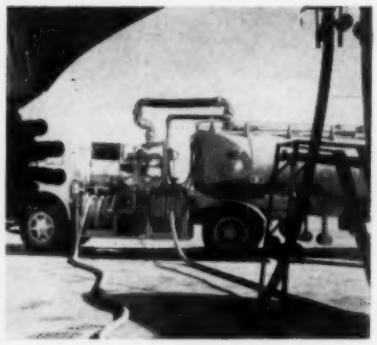
team up strength + flexibility + endurance...



QUICK DISCONNECT FOR A SUPERSONIC WIND TUNNEL—On lines that require frequent disconnecting, such as on this wind tunnel, Chiksan swivel jointed assemblies, teamed with Weco Unions, disconnect quickly, swing out of the way and then back into perfect alignment. **For application details, request report 008.**



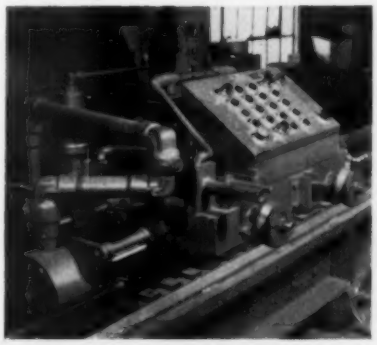
0 TO 2000 PSI IN ONE SECOND—injection molding machine lines must be flexible. Safety is a must. Endurance highly desirable. Chiksan Swivel Joints not only fulfilled these important requirements but their savings in replacement cost soon paid for the swivel joints. **For applicable details request report 001.**



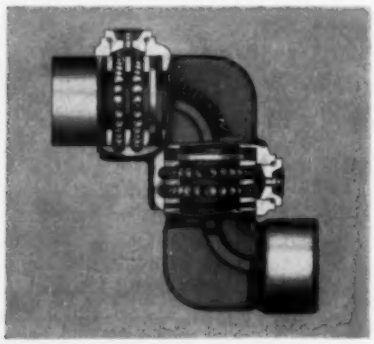
SAFETY LINK FOR JET-FUEL DELIVERIES—In design of trailer tankers for fueling jet aircraft one danger point was the suction line from pump to the trailer. By employing Chiksan Swivel Joints desired flexibility was maintained and the danger of kinking was eliminated. **For application details request report 006.**

When moving machine parts cause tight bend or twist on hose lines, Chiksan Swivel Joints are a ready solution. Or when your design dictates the use of flexible metal lines, Chiksan Swivel Joints allow controlled flexibility. Whenever line endurance, strength and flexibility are desired Chiksan Swivel Joints may offer a ready solution.

Chiksan Swivel Joints with their infinite service life, full 360° rotation and high safety factor, quickly pay for themselves by minimizing hose replacement and by eliminating costly line failure, fluid loss and downtime. For expert advice on your line design problems contact Chiksan. A nearby representative will call, analyze your requirements, and make specific recommendations.



ON THE MOVE 24 HOURS A DAY—Every five seconds right around the clock this machine tests finished pipe with water under pressures up to 1000 psi. Line movement is almost continuous. The solution. For safe, flexible lines of maximum endurance—Chiksan Swivel Joints. **For application details request report 010.**



DESIGN WITH SWIVEL JOINTS—Over 2,000 different types, sizes and styles give you an excellent selection of swivel joints for your design application.

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CHIKSAN COMPANY, 330 North Pomona Ave., Brea, California

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Please send me product application report ☐ .001 ☐ .006 ☐ .008 ☐ .010

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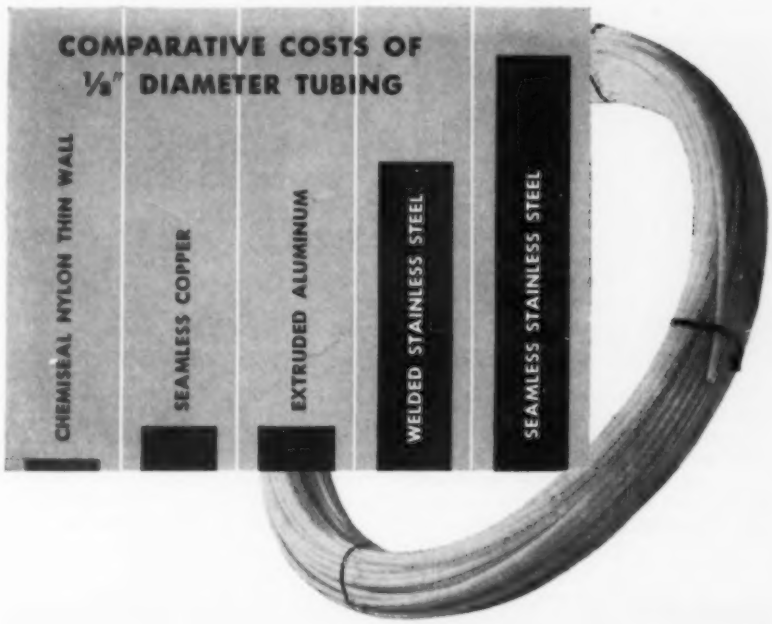
NYLON PRESSURE TUBING COSTS LESS... *Performs Better than Metal*



A decisive cost advantage of CHEMISEAL Nylon Pressure Tubing is shown in this graphic relationship to other tubing materials. Seamless copper and extruded aluminum cost approximately four times as much, while welded and seamless stainless steel costs 29 to 37 times more, respectively. Also, the cost of couplings and installation labor should be considered—CHEMISEAL Nylon Pressure Tubing needs no intermediate couplings or fittings . . . is simple to install. You save on first cost, fittings, and labor.

On the job, other materials don't compare. CHEMISEAL Nylon Pressure Tubing is unaffected by lubricants, alkalies, acids, solvents. It can be twisted, bent, flexed into any position—will resist abrasion, impact, vibrational fatigue. CHEMISEAL Nylon is serviceable from −60° F. to +180° F. (can be heat stabilized for 300° F.); available for 1000 and 2500 psi, conforming to J.I.C. specifications. Diameters range from ⅛" O.D. to largest size commercially made, depending on customer needs.

Discover how you can use CHEMISEAL Nylon Pressure Tubing. Contact one of The Garlock Packing Company's 26 sales offices and warehouses throughout the U.S. and Canada, or write for Bulletin NPT.

THE GARLOCK PACKING COMPANY, Palmyra, N. Y.

United States Gasket *Plastics Division of* GARLOCK

Circle **157** *on Time-Saver Card*

BRIEFS

Aircraft Systems

1. "Review of Hydraulic Filtration" by John A. Ferris, Aircraft Porous Media, Inc., New York.
2. Paper by John C. Bloom, Douglas Aircraft Co.
3. Paper by Conrad H. Cook, The Martin Co., Baltimore.

Automotive

1. Paper by Ian McNeil, London.
2. "Automatic Braking Control" by Francis Leighton, Hydro-Aire.
3. Paper by Robert M. Van House, Research Laboratories, GM Technical Center.

Hydraulic Fluids

1. Panel Discussion by representative of a pump manufacturer, fluid supplier, and equipment supp'ier.

□□□

Rosaen to speak at ASME meeting

Nils Rosaen, president of the Rosaen Co., Hazel Park, Mich., will be the main speaker at the first Fluid Power Systems Division meeting, Philadelphia section, American Society of Mechanical Engineers, Sept. 29.

A dinner will preceed the 7:30 p.m. meeting at the Engineers

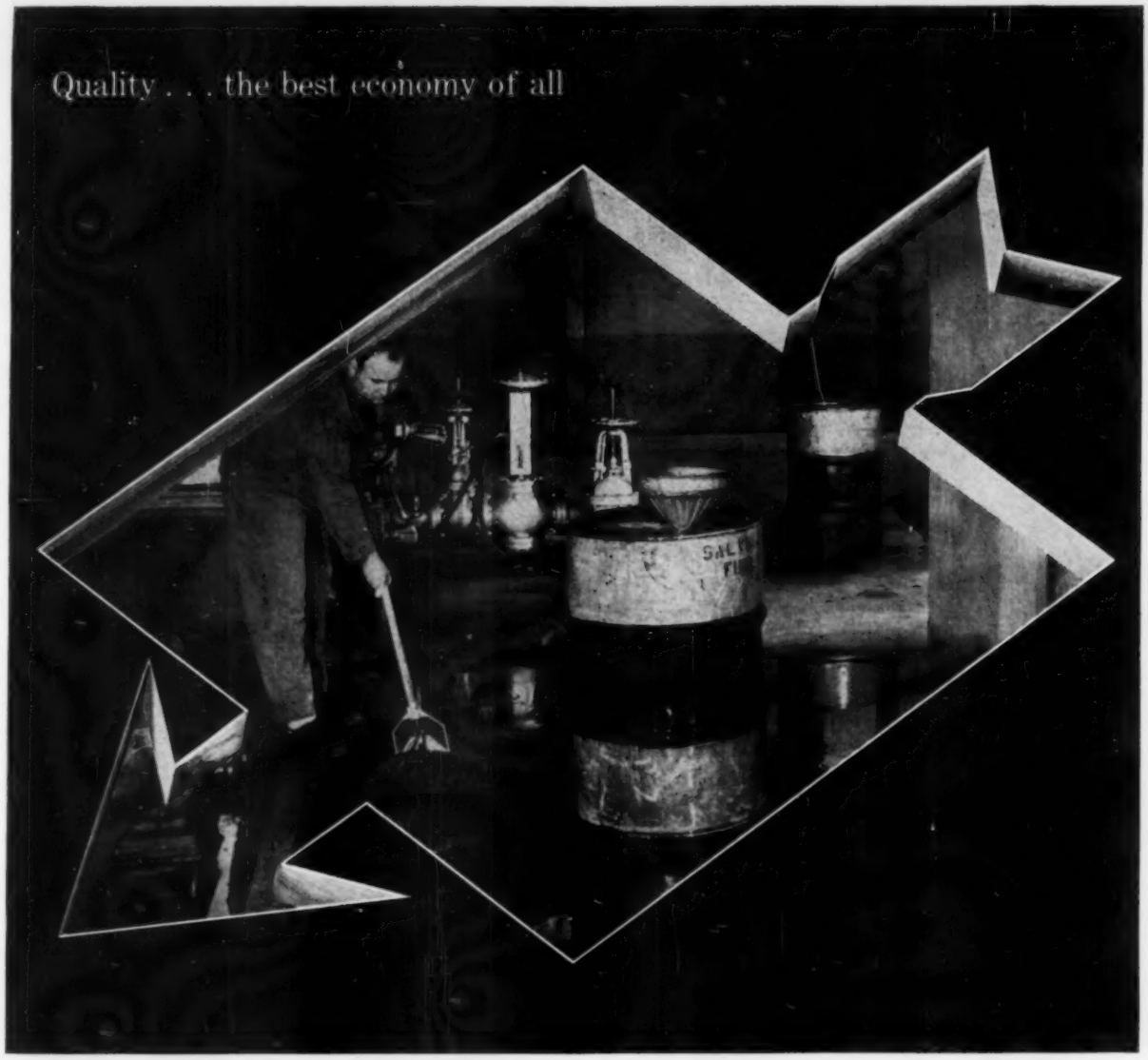
Rosaen

Club, Philadelphia. Rosaen's subject is "Filtration in Hydraulic Equipment."

The Swedish-born Rosaen, 37, was educated at Wayne University, Detroit. Before starting his own company, he was a consultant to Brown & Sharpe Mfg. Co., general manager of Dudco Division, New York Air Brake Co., and a consulting engineer to The Lodge and Shipley Co., Cincinnati.

Rosaen designed and developed the Dual Vane Dudco PF-100 series pumps, and is the inventor of Tell Tale filters and flow meters.

□□□



He's mopping up the mess for the last time

At a leading aircraft research center, high-frequency vibration caused severe oil leakage from hydraulic lines servicing a huge wind tunnel. Many man-hours each month were wasted cleaning up the basement floor underneath, even though drip pans were used extensively.

Now, after a change to a Suntac oil, the vibration-caused leakage has been reduced to a point where "mop-up" is not needed. Hydraulic-fluid consumption has been cut by 4000 gallons a year. That's economy! That's Sun quality—the best economy of all.

If your plant is troubled with a leaky system, a Suntac antileak hydraulic oil can save you money, too. Ask your Sun representative to show you the Suntac desk-top demonstration, or write direct to SUN OIL COMPANY, *Philadelphia 3, Pa., Dept. MH-9. In Canada: Sun Oil Company Limited, Toronto and Montreal.*

SUNOCO

MAKERS OF FAMOUS CUSTOM-BLENDED BLUE SUNOCO GASOLINES

PUROLATOR FILTERS FOR THE PROTECTION OF HYDRAULIC CIRCUITS

G-200M Aircraft Restrictor Filter two-way for hydraulic oil systems metal element

PR 301 ½ GPM line type hydraulic oil filter Micronic element

PR 362 3 CFM in-line vent type Micronic element

G 200 series in-line two-way restrictor filter Metal element, internal connections

PR 312 12 GPM line type filter Micronic element

PR 412-8 12 GPM line type filter Military approval

G-187 3 GPM in-line hydraulic oil filter Metal element

P 32-28 Low pressure, high flow hydraulic oil filter

Effective filtration is essential for optimum performance in hydraulic circuits. To keep a system clean and functioning properly, it is important that the filter be designed specifically to meet the requirements of the job.

Purolator's complete line of filters for hydraulic systems includes models for every set of operating conditions likely to be encountered. A few are shown here; there are many more standard models from which to choose. If your application requires a special filter, Purolator will design and build it. Let Purolator work on your toughest filtration problem.

Filtration For Every Known Fluid

PUROLATOR

PRODUCTS, INC.

Rahway, New Jersey and Toronto, Ontario, Canada

interchangeable with all standard JIC cylinders

With the introduction of the ALL NEW T-J Squair Head, Tomkins-Johnson now offers industry the most complete design range of air and hydraulic cylinders. Presently available in bore diameters from 1½ to 8 inches, the T-J Squair Head is an interchangeable cylinder which produces maximum force and efficiency, with minimum pressures . . . and is also adaptable to the use of low pressure oil as the working medium. Write to The Tomkins-Johnson Co., Jackson, Michigan, for Bulletin #SQ 10-58 and complete details.

CHECK THESE 10 POINTS OP T-J SUPERIORITY

1 One Piece Piston

2 Hard Chrome Cylinder Bore and Piston Rods

3 High Tensile Steel Tie-Rods

4 Cushion Adjusting Screw, Externally Adjustable

5 New Super-Cushion for air, or Self-Aligning Master Seal for Oil (T-J Patents)

6 Solid Steel Heads and Mounting Plates Standard all Models

7 Port Design Allows Minimum Pressure Drop on Inlet or Outlet

8 Chevron Type, Self-Adjusting Rod Packing

9 Piloted Packing Gland—Absolute Alignment

10 Piston Rod, Extra Strong—Polished and Chrome Plated for Efficiency and Protection

T-J TOMKINS-JOHNSON

NEW PRODUCTS

Components, tools and equipment for fluid power systems. For more information fill in and mail post card bound in this issue.

RADIAL PISTON PUMP . . . for hi pressure variable delivery

Designation: PR-18

Features: Positive separation of cylinder barrel and pintle maintained by two caged needle bearings. Running clearance, pressure

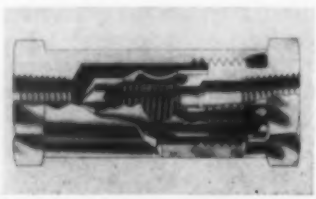
sealing guaranteed. Check valve in shaft assures positive lubrication of pintle valve, cylinder barrel, and shaft support bearings. Seals against sucking air into active system. Hydraulic load carried by bronze crossheads, assuring low friction loss.

Specifications: Has 18 gpm capacity. Pressure rated to 3000 psi, intermittent to 5000 psi. Weighs 350 lbs. Available with five different displacement controls: stem, handwheel, servo, reversing, compensator.

Texas Hydraulics, Inc.
Austin, Texas
Circle **300** *on Time-Saver Card*

CHECK VALVES . . . have low back pressure

Designation: 750 Series



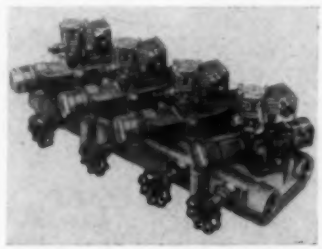
Features: Extremely low back pressure, fast action, versatility. Built for 300 psi in air, oil, water. Standard cracking pressure of 0.5 psi, higher on order. Guaranteed leakproof at all pressures. These disc-type valves are sensitive to reversal of flow. Fast acting.

Specifications: Opening pressures to 1/16 psi available from stock. In brass in 1/8 pipe size, all standard fittings.

Bodnar & McDermott Mfg. Co.
Mount Vernon, N. Y.
Circle **301** *on Time-Saver Card*

4-STATION MANIFOLD . . . has integral manual shut-off

Features: Will accommodate four control valves—three 4-way 3/4" NPT, single or double solenoid, and one 3/4" NPT single solenoid. Simplifies piping, reduces original installation material and labor costs. Cuts in-service maintenance expense and machine down-time. Shut-off valves permit servicing of



control valves without shutting main air supply to manifold. Built-in junction boxes on solenoid pilots reduce complexity of machine wiring, further cutting installation, maintenance costs.

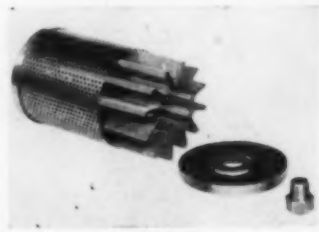
Specifications: Common inlet and exhaust ports, tapped 1 1/4" NPT at both ends. Valve ports tapped 3/4" NPT. Four drilled mounting bosses provided.

Valvair Corporation
Akron, Ohio
Circle **302** *on Time-Saver Card*

SUCTION FILTERS . . . to 140 microns

Designation: 3000 Series

Features: For low-cost removal of dirt, rust, etc., in flows from 8-50 gpm. Have standard 100-mesh monel element for filtration to 140 microns. Steel perforated housing insures maximum flow with minimum restriction. Easily cleaned,



no special maintenance required. Compression sealing top and bottom assures positive seal. Can be installed individually, or in multiples of two or more.

Specifications: Filtering area from 81 to 505 sq. in.

General Filters, Inc.
Novi, Mich.
Circle **303** *on Time-Saver Card*

TWO ACCESSORIES . . . for air cylinders

Designation: Accessory pin, 80-AB; bleeder valve, 70-VR.

Features: Pin (shown) can be provided at either cylinder end, has throw of .062". Actuated by hardened cam-boss mounted on piston rod. Pin motion used to actuate an

electric switch or small button to control other equipment in sync with air cylinder. Valve also can be installed at either cylinder end. Bleeds air from other equipment as cylinder rod reaches end of stroke. Features same type pin.

Allenair Corp.
Mineola, N. Y.
Circle **304** *on Time-Saver Card*

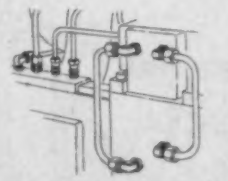
Continued on page 62

NEW WEATHERHEAD

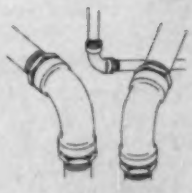
TEF-SEAL® NUT

makes every pipe connection LEAKPROOF!

SAVE - expensive maintenance costs
SAVE - labor and downtime
SAVE - valuable fluids



FOR HYDRAULIC FLUIDS



FOR ALL PROCESSING INDUSTRIES

FOR WATER

Eliminates leaks on all pipe threads—Dry Seal or standard. No pipe compound required. Quick, easy installations in cramped quarters where wrench clearance is limited.

Tef-Seal Nuts are an economical substitute for straight thread "O" ring boss fittings using original female pipe ports. Tef-Seal gives you positive seal on directional fittings like tees and elbows without distorting mounting bosses or damaging expensive valves and pumps.

NEW FORGED STEEL PIPE FITTINGS

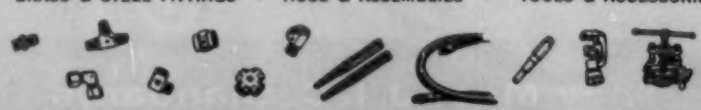
Available in a wide range of sizes and styles, to meet most piping requirements.

Weatherhead steel pipe fittings are rugged, dependable for high pressure applications. They are precision machined from AISI 12L14 material to meet GMC dimensional standards. Weatherhead's exclusive ball-drilling process leaves no edges or sharp corners, eliminates turbulance and insures smooth, full flow. Corrosive resistant Weathercote finish is standard on these fittings, permits their use with all types of hydraulic fluids, water and air.

SPECIFICATIONS

Pressure Rated at 3,000 p.s.i. working pressure
Proof Tested: 15,000 p.s.i. in sizes up to 1¼"
10,000 p.s.i. in sizes 1½" and up
Each fitting is marked with its individual rating
All threads are American Standard Taper Pipe Threads — Dryseal (N.P.T.F.)

BRASS & STEEL FITTINGS • HOSE & ASSEMBLIES • TOOLS & ACCESSORIES



Write for your copy of our new General Industrial Catalog. Ask for Catalog C300.

THE WEATHERHEAD COMPANY • FORT WAYNE DIVISION
Dept. AH-9, 128 W. Washington Blvd., Fort Wayne, Ind.
In Canada: The Weatherhead Co., Ltd., St. Thomas, Ont.

FILTER Quality cannot be

SINCE 1943

SUMP TYPE

LINE TYPE

They Meet J. I. C. Standards

compromised by FILTER Price!

THE ANSWER TO FILTER Quality IS

MARVEL

SYNCLINAL FILTERS

Over 900 O.E.M.'s can't be wrong!

16 years ago, Marvel Engineering Co. produced the first filter designed to maintain the cleanliness of oils, imperative in hydraulics and other low pressure circulating systems. Acceptance of Marvel Synclinal Filters to meet these rigid requirements sparked the surge to our leadership in this field, the status we presently maintain. This fact is attested by well over 900 Original Equipment Manufacturers, who are installing Marvel Synclinal Filters as standard equipment.

For further information— write, wire or phone:

Check these EXCLUSIVE Marvel Features:

- **BALANCED SYNCLINAL DESIGN.** The all-important balance between *ACTIVE* filtering area and storage capacity for filtered out particles in Marvel Synclinal Filters provide longer periods of efficient filtration and dependable protection on hydraulic and other low-pressure circulating systems.
- **CONSTRUCTION.** Marvel Filters are of sturdy construction with all parts interchangeable. Should any part become damaged by accident or mishandling, you need only to replace the damaged part rather than purchasing a complete new filter. Your first cost may very well be your only cost.
- **VERSATILITY.** Marvel Synclinal Filters are available for Sump or Line installations. Eight individual capacity sizes from 5 to 100 G.P.M. You can get a filter for the particular fluid you are using—regular petroleum base hydraulic oils, all types of Fire-resistant hydraulic fluids, coolants, lubricants or water.
- **DEGREE OF FILTRATION.** Filtering media in Marvel Synclinal Filters is Monel Wire Cloth available in mesh sizes of 30-40-50-60-80-100-150 and 200 to meet your degree of filtration requirements. Before fabricated into Marvel Synclinal Filters, all wire cloth is subjected to rigid inspection at our plant. No factory rejected cloth or remnants are ever used.
- **EASY TO CLEAN.** Marvel Filters are easily disassembled, thoroughly cleaned and re-assembled in a matter of minutes—resulting in the equivalent of a brand new filter, ready for another long period of efficient service.
- **IMMEDIATE DELIVERY.** Marvel not only delivers a top grade filter in both quality and performance, but delivers IMMEDIATELY—a phone call can get your shipment on its way TODAY!

MARVEL ENGINEERING COMPANY

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it makes sense

ONE SOURCE
ONE RESPONSIBILITY

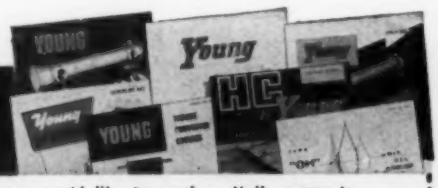
for all
COOLING
Requirements

Young / *Heat Transfer Specialists*

ONE source, one responsibility for all cooling requirements is the sensible approach to solving heat transfer problems. By using one reliable source, you automatically solve problems of service, and there is never a question of responsibility for performance. Young's wide range of products and over 30 years experience in designing, engineering and manufacturing radiators, oil coolers and heat exchangers qualifies them as the most logical source for all your cooling needs. Let us show you what undivided responsibility can mean in the way of economy, quality control and efficiency of performance. Write, wire or call without obligation.

YOUNG RADIATOR COMPANY
RACINE, WISCONSIN

Acquaint yourself with Young's wide range of products



MAIL COUPON TODAY FOR FREE CATALOGS...

Check the catalogs and literature you would like to receive. Mail coupon to Young Radiator Co., Racine, Wisconsin, Dept. 449-J

- ☐ Cat. No. 1652 — Young Supercharger Air Intercoolers
- ☐ Cat. No. 1356 — Young Jacket Water Coolers
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- ☐ Cat. No. 1258 and No. 1156 — Shell and Tube Heat Exchangers
- ☐ Cat. No. 1054A — Young Torque Converter Coolers
- ☐ Cat. No. 3558 — Type 'OH' Unit Oil Coolers

Name .....

Company .....

Address .....

City ..... Zone ..... State .....

Circle **173** *on Time-Saver Card*

NEW PRODUCTS

NEW MOUNTING BASES . . . for air valves

Designation: Universal and Gasket Mounted

Features: Greater piping versatility offered by alternate bases for series "CC" 4-way directional air

control valves. Universal base used when combination piping and gasket mounting desired; second base is used when gasket mounting required. Bottom ports O-ring grooved for mounting directly to manifold or machine pad.

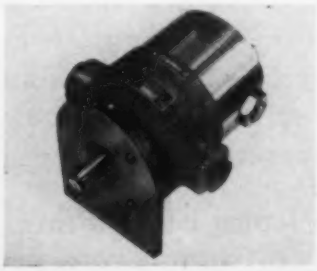
Specifications: Eight ports tapped ¼ or ⅜" pipe size.

Hannifin Co.
Des Plaines, Ill.
Circle **305** *on Time-Saver Card*

HYDRAULIC PUMP . . . for pressures to 1500 psi

Designation: Model 1372

Features: Kingsbury slipper type. Supports load on hydrodynamic oil film, giving minimum friction,



quiet operation, maximum dependability. Slippers fit bore contour.

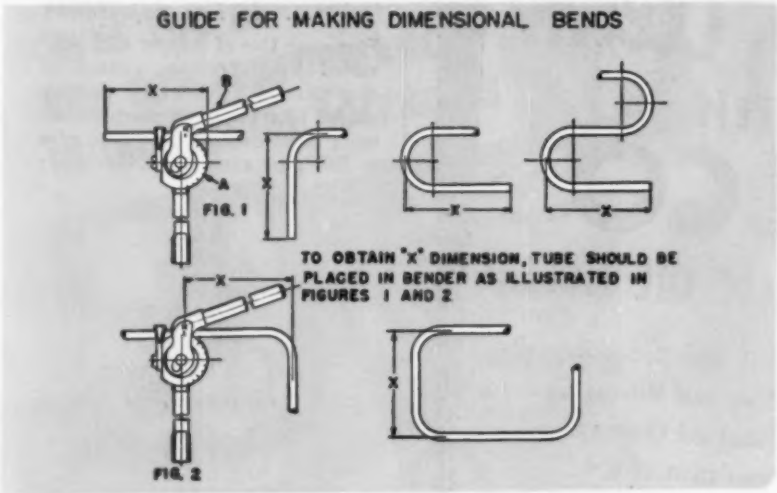
Specifications: For applications from ½-2 tons, pressures to 1500 psi and 1-2 gpm capacities.

Mechanisms, Inc.
Urichsville Ohio
Circle **306** *on Time-Saver Card*

Continued on page 64

IMPERIAL *Engineering and Data File*

ENGINEERED TUBE FITTINGS — VALVES — TUBING TOOLS


GUIDE FOR MAKING DIMENSIONAL BENDS
FIG. 1
TO OBTAIN "X" DIMENSION, TUBE SHOULD BE PLACED IN BENDER AS ILLUSTRATED IN FIGURES 1 AND 2
FIG. 2

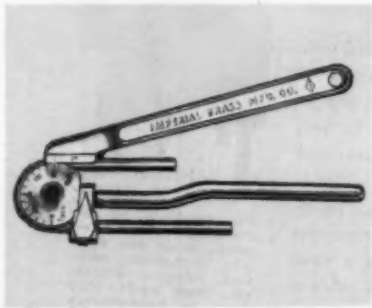
Dimensional tube bends easily made with Imperial Blue Dot Benders

It's no trick to make bends at any desired point — that conform to dimensional requirements as to developed tube length and location — when you use Imperial Blue Dot Benders. Full instructions with each bender.

Imperial Benders are of the open side type. They slip over the tubing where the bend is desired — handy in hard-to-get-at places or when tubing has one end connected.

They form neat, accurate bends on hard or soft tubing without annealing. Calibrated for bending any angle up to 180°.

For complete information on Imperial's complete line of Tube Cutters, Flaring Tools, Sawing Vises, Reaming, Swaging, Pinch-off and Re-facing Tools



. . . write for Bulletin No. 3088 and Hand Book No. 369-B.

Improved bending tools remove danger of installing hazards in tubing systems

Restriction of flow, caused by flattening the tube when making bends, is a common hazard in tubing systems. It retards operation of hydraulic and pneumatic equipment . . . delays signals in instrumentation . . . starves refrigeration systems.

Stress points in bends are a second hazard. These points build up due to scoremarks in the tubing and can result in complete failure under vibration, or under hydraulic surge conditions.

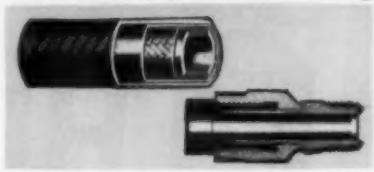
Imperial Tube Benders are specially designed to protect against deformation of the tube, against die marks or other surface imperfections, no matter what type of tubing is being used.

Included in Imperial's full line of tube benders are Blue Dot Individual Benders for ⅛" to ⅞" O.D.; combination benders for 2 to 7 sizes; and Gear-type Benders for ⅜" to 1⅛" O.D. All Imperial Benders will bend hard or soft drawn copper, steel, aluminum, stainless steel, thin wall conduit . . . even aircraft-type stainless steel tubing.

IMPERIAL

THE IMPERIAL BRASS MFG. CO.
6300 W. Howard St., Chicago 48, Illinois
In Canada: 18 Hook Ave., Toronto, Ontario

NOW—rubber-covered pressure hose that requires no skiving



Because of a new Imperial Hose, you can now obtain and utilize all the advantages of a rubber-covered wire-braid pressure hose — resistance to abrasion, mildew, weather, oil — and at the same time eliminate costly time-consuming skiving.

Hose can be used with hydraulic fluids, gasoline, oil, grease, liquefied petroleum gas, Freon 12, air and water. Temp. range: -40° F. to +275° F. Meet S.A.E. specifications. Available are a broad range of hose and coupling types and sizes. Re-usable couplings are cadmium plated steel, furnished with either long dryseal pipe thread or 37° flare end connections.

Write for Bulletin No. 3040.

Flare quality vital to making tight 37° flare fitting joints

The quality of a 37° Flared Fitting Joint is no better than the quality of the flare that has been made on the tubing. Even the finest fitting will fail if the flare isn't right.

Experience of countless users has demonstrated this on jobs of all types.

Flares that are rolled-in-the-air, instead of being formed against the die block, are a big aid to better joints. Wall thickness of tube is retained without thinning at its vital point — the base — to assure a far stronger flare.

Imperial 37° Flaring Tools in several models offer this feature. In addition, burnishing action that assures a smooth, true surface — so important to a tight joint — is provided by a special device in the feed mechanism. The Imperial line includes 37° Flaring Tools for tubing in all metals, sizes 3/16" to 2" O.D.

Imperial also offers a complete line of 37° Flare Fittings in brass, steel and stainless steel.

Write for Catalog No. 200.

CONTACT YOUR INDUSTRIAL DISTRIBUTOR OR WRITE TO:

IMPERIAL BRASS MFG. CO.
Dept. AM-99, 6300 W. Howard St.
Chicago 48, Illinois

Please rush me:
Bulletins ☐ No. 3040 ☐ No. 3088 ☐ No. 200 ☐ No. 369-B

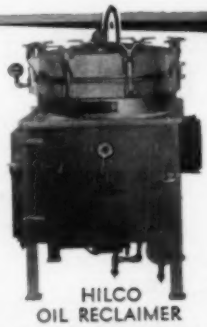
Name.....
Title.....
Company.....
Street.....
City..... Zone... State.....

Keep YOUR HYDRAULIC SYSTEM Clean with HILCO HYDRAULIC OIL FILTERS

- No More Varnish and Sludge Deposits
- No More Flushing and Manual Cleaning
- No More Frequent Oil Changes
- No More Accumulation of Dirt

Filter life up to a year eliminates usual frequent draining, refilling of systems.

HILCO Hyflow Oil Filters trap dirt, acids, rust, sludge, gums, resins . . . all solid contaminants, and keeps your hydraulic system clean and in top running condition at all times. To you, this means longer oil life, reduced wear and abrasion . . . hence, less down time and lower maintenance costs giving you continuous equipment operation with increased production. Hydraulic unit sensitivity depends upon a clean system. HILCO Hyflow filters remove solids as soon as they enter the system and retain much of the moisture which enters the oil from the atmosphere and from condensation. Obtain the full capacity and economy of your equipment by keeping it in top running condition with HILCO. Hydraulic Oil Filters come in stationary or portable models. They can be hooked into hydraulic systems without interrupting equipment operation.



HILCO
OIL RECLAIMER

For complete oil reclaiming. Removes solids, acids and volatile impurities; moisture, solvents, gasses, etc., from hydraulic fluids by heat-vacuum process.

• SEE FOR YOURSELF HOW HILCO keeps your Hydraulic System Clean . .

WRITE TODAY FOR THIS *Free* BOOKLET

Recommendations at no Obligation

THE HILLIARD *Corporation*

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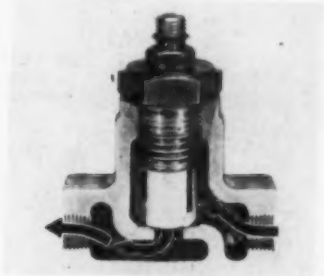
IN CANADA: UPTON BRADEEN JAMES LTD. 890 YONGE ST. TORONTO • 8760 VERVILLE ST. MONTREAL

Circle 63 on Time-Saver Card

NEW PRODUCTS

SPEED CONTROL VALVES . . . for fine adjustment

Features: Use of poppet with four varied length orifices instead of conventional needle type control. Varied lengths permit sharp adjustment of exhaust air flow from zero to full pipe capacity. Exhaust air

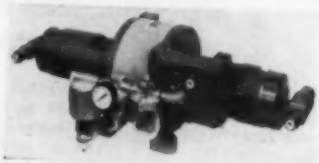


flow adjustment obtained by positioning adjusting steam. For fast return, air pressure lifts poppet off the seat, permitting unrestricted full pipe capacity air flow. Buna-N poppet seat provides positive seal and eliminates wear. Stem lock nut assures positive locking of adjusting stem.

Automatic Valve Co.
Farmington, Mich.
Circle **307** *on Time-Saver Card*

AIR-POWERED PUMPS . . . develop pressures to 50,000 psi

Features: For locations where electricity is not available, or where such power would be dangerous to use. Can pump many liquids. Offers duplex design—one piston



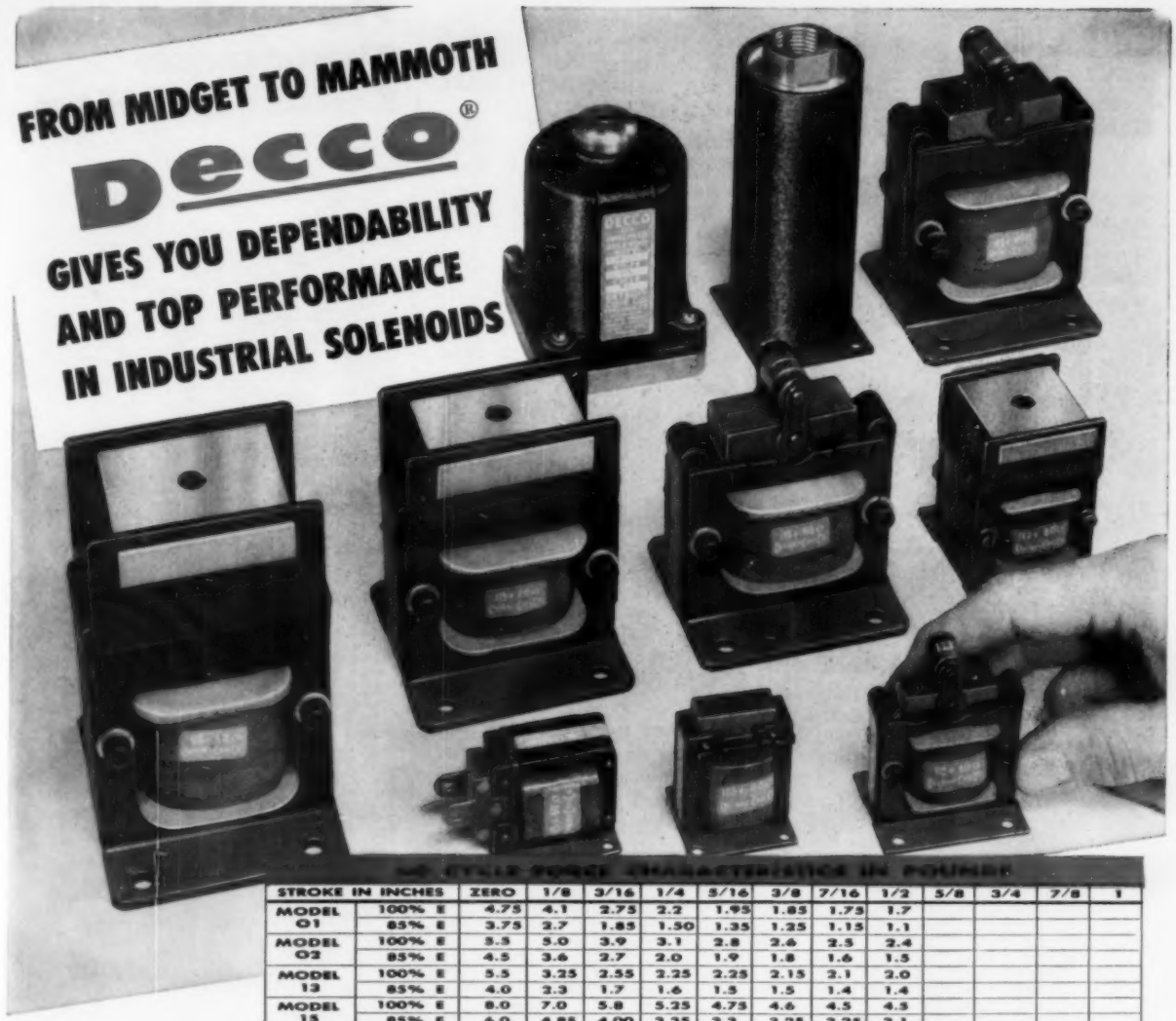
provides suction while other delivers high-pressure fluid. Crank-arm action eliminated. Automatic, air-transfer valve in pump reverses air pressure flow from one side of drive piston to other, maintaining continuous pumping action as long as air pressure supply is maintained. External check valve assemblies easily maintained or replaced. Need

Continued on page 66

FROM MIDGET TO MAMMOTH

Decco®

GIVES YOU DEPENDABILITY AND TOP PERFORMANCE IN INDUSTRIAL SOLENOIDS



STROKE (TORQUE) CHARACTERISTICS IN POUNDS

STROKE IN INCHES		ZERO	1/8	3/16	1/4	5/16	3/8	7/16	1/2	5/8	3/4	7/8	1
MODEL 01	100% E	4.75	4.1	2.75	2.2	1.95	1.85	1.75	1.7				
	85% E	3.75	2.7	1.85	1.50	1.35	1.25	1.15	1.1				
MODEL 02	100% E	5.5	5.0	3.9	3.1	2.8	2.6	2.5	2.4				
	85% E	4.5	3.6	2.7	2.0	1.9	1.8	1.6	1.5				
MODEL 13	100% E	5.5	3.25	2.55	2.25	2.25	2.15	2.1	2.0				
	85% E	4.0	2.3	1.7	1.6	1.5	1.5	1.4	1.4				
MODEL 15	100% E	8.0	7.0	5.8	5.25	4.75	4.6	4.5	4.5				
	85% E	6.0	4.85	4.00	3.35	3.3	3.25	3.25	3.1				
MODEL 16	100% E	12.0	8.5	7.15	6.75	6.6	6.5	6.5	6.4				
	85% E	10.0	6.1	5.15	4.75	4.6	4.5	4.5	4.5				
MODEL 17	100% E	16.0	11.2	9.9	9.0	8.5	8.1	8.0	8.0				
	85% E	14.0	8.2	7.0	6.3	6.2	6.1	6.0	6.0				
MODEL 18	100% E	18.5	14.5	12.25	11.4	11.0	10.5	10.25	10.25				
	85% E	16.0	10.5	9.0	8.25	7.75	7.5	7.25	7.25				
MODEL 20	100% E	25.0	18.0		13.5		12.5		12.5	12.5	12.25		
	85% E	20.0	12.0		9.0		8.5		8.5	8.5	8.5		
MODEL 21	100% E	35.0	20.0		16.0		15.0		15.0	15.0	15.0		
	85% E	25.0	14.0		10.5		10.25		10.0	10.0	10.0		
MODEL 51	100% E	40.0			23.0		21.0		20.0	20.0	20.0	20.0	20.0
	85% E	30.0			17.0		15.5		14.5	14.5	14.5	14.5	14.5
MODEL 52	100% E	45.0			28.0		25.0		25.0	25.0	25.0	25.0	25.0
	85% E	33.0			19.0		17.0		17.0	17.0	17.0	17.0	17.0
MODEL 53	100% E	50.0			37.0		32.0		30.0	30.0	30.0	30.0	30.0
	85% E	36.0			25.0		22.0		20.0	20.0	20.0	20.0	20.0

DECCO'S patented construction and finest quality materials have greatly extended the service life of the solenoid. Silicon steel laminations give top efficiency. Hardened beryllium-copper plungers reduce friction and wear. Shock absorbing construction assures long service life. Non-magnetic, stainless steel striker-plates . . . heavy Nylclad magnetic wire . . . high temperature flow-point, molded nylon bobbins, all contribute to the dependability and stamina which make DECCO solenoids the best buy in the market today.

There is a type, model and size DECCO solenoid for every requirement. Write for DECCO brochures #572 standard models or #581 miniature models.

Decco SOLENOIDS

DETROIT COIL COMPANY

2435 HILTON ROAD, FERNDALE 20, MICHIGAN

NEW PRODUCTS

maximum pressure of 100 psi to operate.

Specifications: Develops liquid pressures to 50,000 psi at temperatures to 500 F. Packing is alternate leather and bronze chevron-type. Others available for special application.

American Instrument Co., Inc.
Silver Spring, Md.
Circle **308** *on Time-Saver Card*

FILTER ASSEMBLIES . . . for service to 5000 psi

Designation: Rigimesh

Features: Use ultrafine wire mesh filter elements, made rigid by process that bonds all cross wires to each other. No relief valve offered. Reinforced for 4500 psi differential pressure. "Tortuous path" of mesh with high dirt capacity and long service interval good for hydraulic

fluids. Optional features include by-pass relief valve, built-in differential pressure indicator to signal when cleaning required.

Specifications: Gives 98% removal ratings of 2, 5, and 10 micron-sized particles. From 0-5000 psi, −65 to +275F.

Aircraft Porous Media, Inc.
Glen Cove, N. Y.
Circle **309** *on Time-Saver Card*

FIRE-RESISTANT FLUID . . . is water-in-oil emulsion type

Designation: Sunsafe

Features: Fire-resistant, high viscosity index (130), good film strength at temperatures to 150 F. Antiwear, antirust. Two grades available—for industrial machines, systems and hydraulically-operated mining machinery. Non-foam, good emulsion, thermal, and oxidation stability.

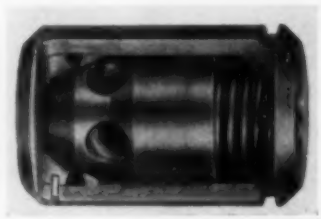
Specifications: For pressures to 2000 psi. Oil-water ratio is 60:40

Sun Oil Co.
Industrial Products Dept.
Philadelphia, Pa.
Circle **310** *on Time-Saver Card*

CHECK VALVE INSERT . . . is cartridge type

Designation: Kepsel

Features: To eliminate expensive machining, provide positive sealing action, long life. Flexible seat



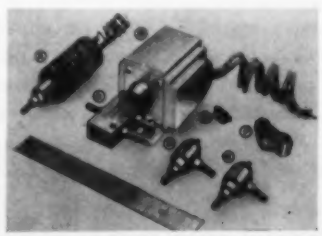
seal not hurt by dirt. For sub-plate and manifold block assemblies, pump suction inlets, pump conversions. Leakproof at all pressures, maintains low pressure drop at full flow, eliminates all threaded connections.

Specifications: Constructed of steel, equipped with Buna-N seal for working pressures to 3000 psi. Temperature range −40 to +300 F with cracking pressure of 1-2 psig.

Kepner Products Co.
Summit, Ill.
Circle **311** *on Time-Saver Card*

MINIATURE AIR VALVE SOLENOIDS . . . for ac and dc

Designation: Models AVS-12, 24, 115

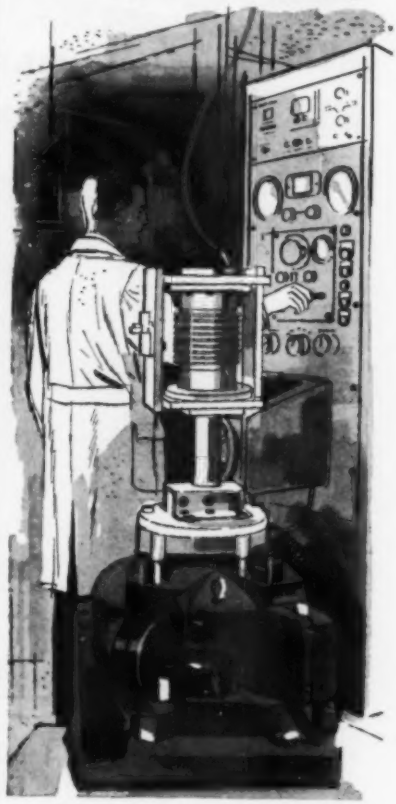


Features: These two miniature solenoids have many uses. DC for operation of MAV-2 miniature 2-way air valves and MAV-3 3-way air valves. AC for 2-, 3-, or 4-way

Continued on page 70

Flexonics Research Laboratories

Applied Research... Development...Testing



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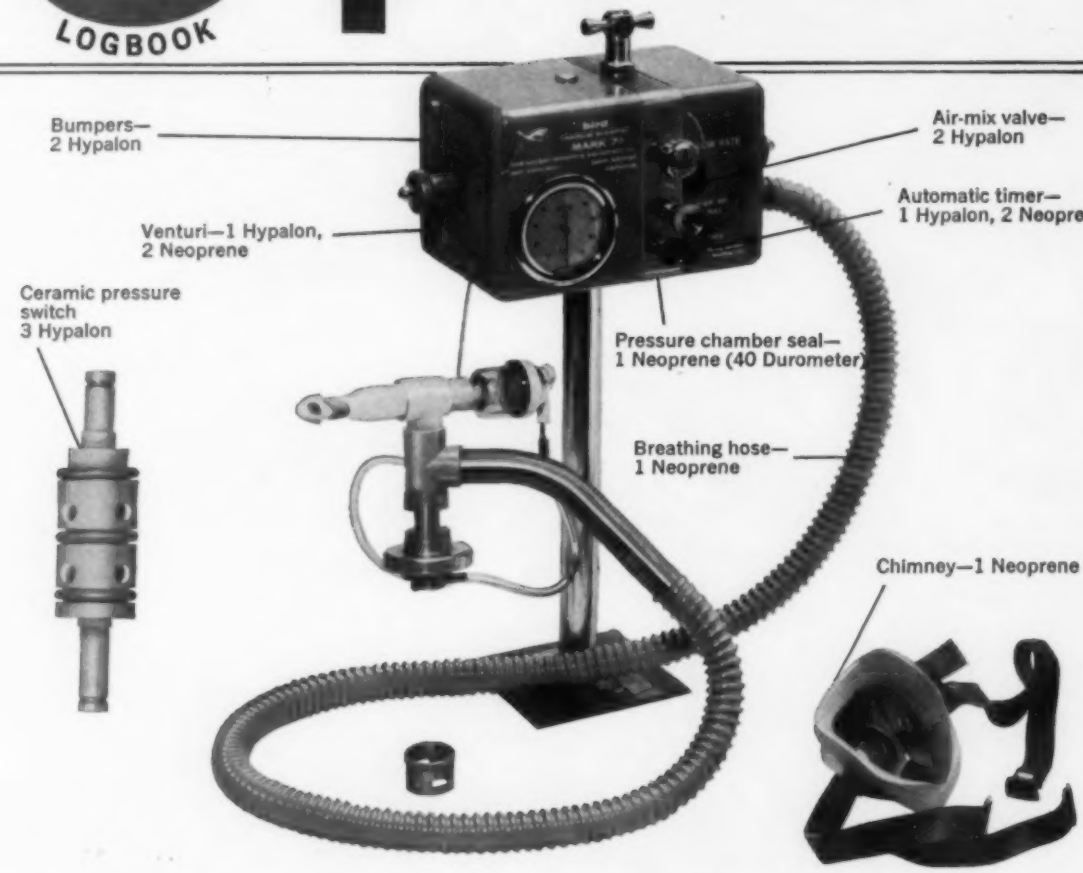
Circle **56** on Time-Saver Card

NATIONAL® OIL SEAL LOGBOOK

For a precision respirator



Uses National Hypalon O-Rings for dependability in home and hospital

20 million cycles of perfect operation. Years of shelf life. Sporadic operation—long idleness, prolonged periods of operation. Extreme sensitivity, precision mechanism. Regular exposure to oxygen, ozone, medication. Reliability that can literally mean life or death.

These are some of the requirements National® O-Rings meet in the revolutionary new Bird MARK 7® Respirator. Introduced little over a year ago, the compact, light-weight Bird MARK 7 is in use throughout the Free World and is hailed by anesthesiologists, surgeons and hospitals as a major advance in therapy for serious disorders such as polio, pneumonia, other lung disorders and coronary problems affecting breathing.

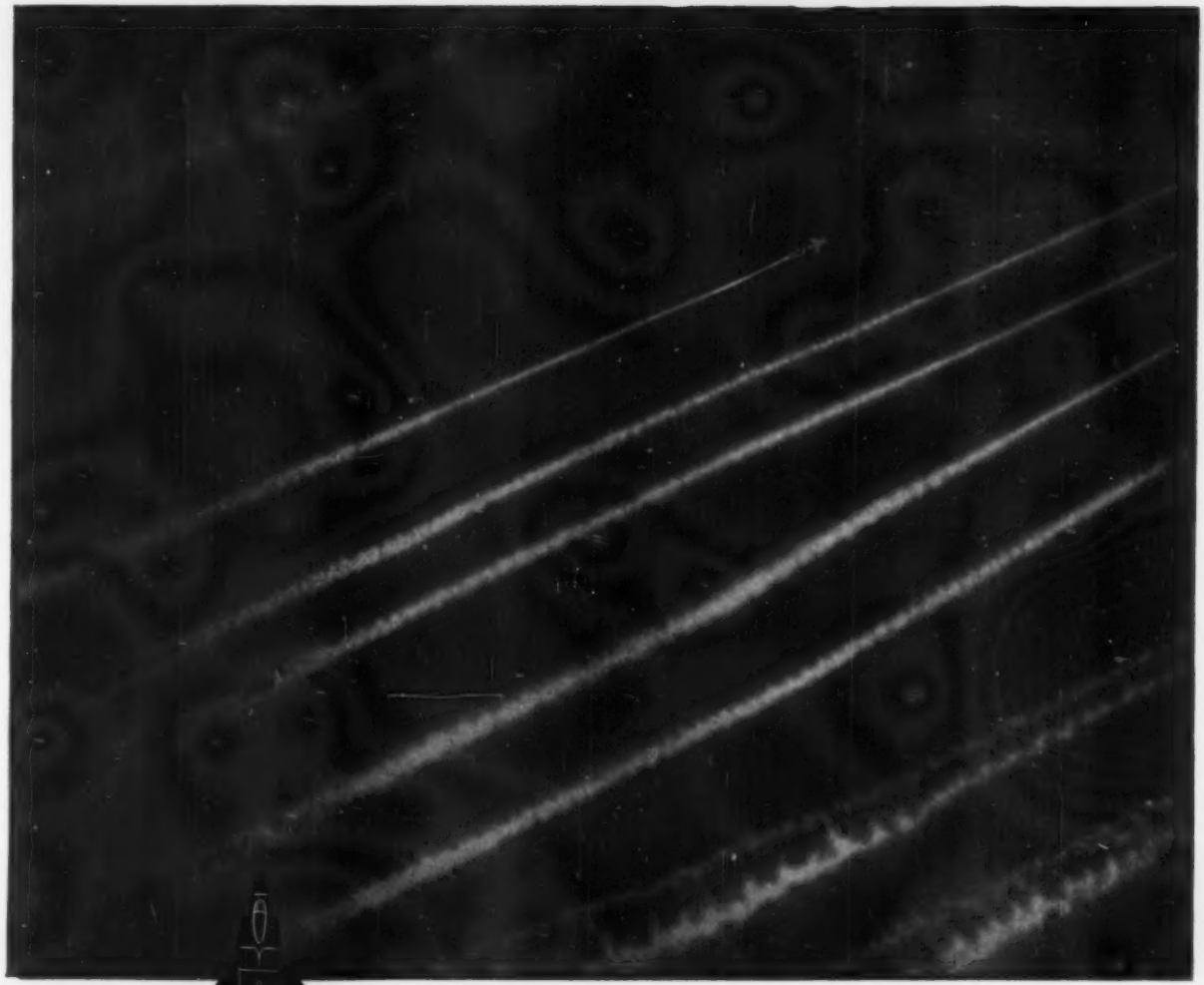
National Welding Equipment Company, makers of the Bird respirator, state that the high order of dependability could not have been achieved without National Hypalon O-Rings. In addition to their stability vs. oxygen, moisture, medications and gases, the Hypalon rings are rugged, and are not damaged when press-installed over extreme-hardness ceramic bushings.

A total of 15 National O-Rings are used in the Bird MARK 7. Nine are Hypalon, five are conventional 70 Durometer neoprene rings and the 15th is a large 40 Durometer Neoprene ring used as a static seal between the pressure chamber and main chassis.

National O-Rings are available in standard sizes, commercial grade, or in special compoundings including Hypalon. For details or O-Ring engineer assistance, call the nearest National Seal engineer. Look in the Yellow Pages, under Oil Seals or O-Rings.

8162

NATIONAL SEAL
Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
Plants: Redwood City and Downey, California
Van Wert, Ohio



Aviation

There are few industries which, for speed of evolution and progress, can be compared with the aircraft industry. The key to this rapid growth has been research, and it is in this field that 'VSG' variable delivery hydraulic pumps and transmission gears have played an important part not only in this country but overseas.

Test rigs of various kinds both for airframe and jet engine development have incorporated 'VSG' equipment as being most suitable for giving that precise control necessary to simulate the required conditions.

This is just another of the highly varied applications of 'VSG' which has now been serving modern industry for over fifty years.

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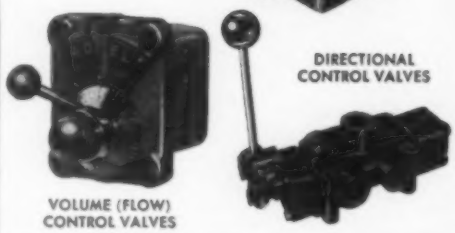
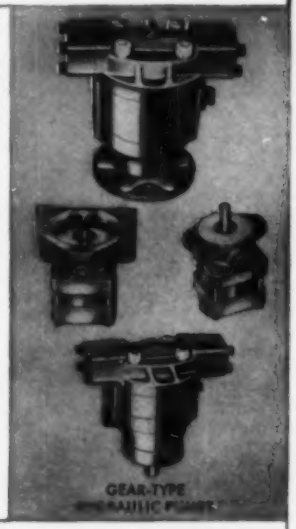
BETTER MACHINE CONTROL...
FOR BETTER MACHINE PERFORMANCE

PILOT OR SOLENOID OPERATED VALVES



DIRECTIONAL CONTROL VALVES

VOLUME (FLOW) CONTROL VALVES



GEAR-TYPE HYDRAULIC PUMPS

New Industrial Gear Type Hydraulic Pumps with capacities from ¼ to 35 GPM at pressures to 1500 PSI and speeds to 3600 RPM.

The diagrams show but two of innumerable circuits and systems where these versatile pumps and control valves can be used to advantage.

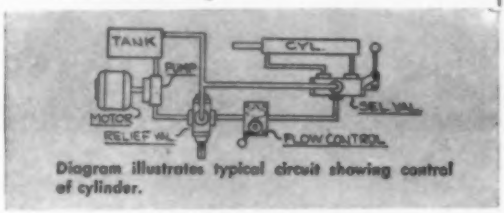


Diagram illustrates typical circuit showing control of cylinder.

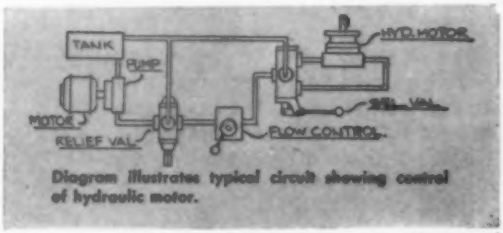


Diagram illustrates typical circuit showing control of hydraulic motor.

For metal working machines, industrial equipment, farm machinery, construction equipment, motor vehicles and marine applications... *Specify* ADEL *Precision-Engineered Hydraulics* for every mechanical operation in every industry.

Complete engineering specifications are available upon request.

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Circle **3** on *Time-Saver Card*

NEW PRODUCTS

valves. Solenoid coils easily removable, replaceable.

Specifications: DC operating pressure is 150 psi. 12v., .64 amps and 24 v., .32 amps. Measure 1⅜x2⅝₁₆". AC is 110-125 v., .81 amps. Measure 2x2¹⁄₁₆x3⅜₁₆" with mounting foot.

Clippard Instrument Laboratory, Inc.
Cincinnati, Ohio

Circle **312** *on Time-Saver Card*

PLASTIC COIL SLEEVE
. . . protects hose assemblies

Features: Easily installed. Thermal and chemical resistant. Flexible. Protects hose lines from abrasion, insulates hot hose applications. Retains shape and flexibility under

temperatures conditions from —20 to +200 F. Unaffected by hydraulic oils.

Specifications: Protects hoses with sizes from ¼-2" diameter. Sleeve for hoses up to ⅝" diameter supplied in coils of 50 ft.; for larger size hoses, 25 ft. lengths.

Aeroquip Corporation
Jackson, Mich.

Circle **313** *on Time-Saver Card*

POROUS METAL DISC
. . . for 10 micron filtration

Features: Constructed completely of stainless steel fibers, designed for low flow and high contaminant or product collection. As replacements for multiple-stacked disc

Continued on page 72

Circle **102** ➡

EASY AS IT LOOKS!

NEW ADD-A-UNIT MANIFOLDS WITH ELECTRICAL PLUG-INS SIMPLIFY MULTIPLE AIR INSTALLATIONS

Here's an important air valve "first"! We have now engineered our MAC Dual-Seal valves with optional *add-a-unit manifold bases*. Two to ten of the bases can be combined quickly and easily—giving you a single, compact, inexpensive manifold to suit your exact requirements, take up far less space.

As the picture shows, the manifold forms common inlet, common exhaust and common conduit channels. The side and bottom cylinder ports come in either ⅜" or ½" sizes. And if you wish to use more than one pressure, "add-a-units" let you isolate valves and feed pressure from each end. Bottom inlet ports are available, too.

Now, we also have simplified valve wiring. Each manifold base has female receptacles (see picture) with attached plug-in leads for quick, positive connections. The valve body has male terminals pre-wired to the MACsolenoid. To connect, just plug in the body to the base. It's as easy as plugging in a lamp . . . and it lets you replace a valve without any additional wiring. MAC design also offers standardized bodies, bases and solenoids (single or double); circular air-flow; and the valve is J.I.C. specified. Put Dual-Seal efficiency in your air operations now! Write for complete information or phone your MAC representative.

A. B. Lemmon

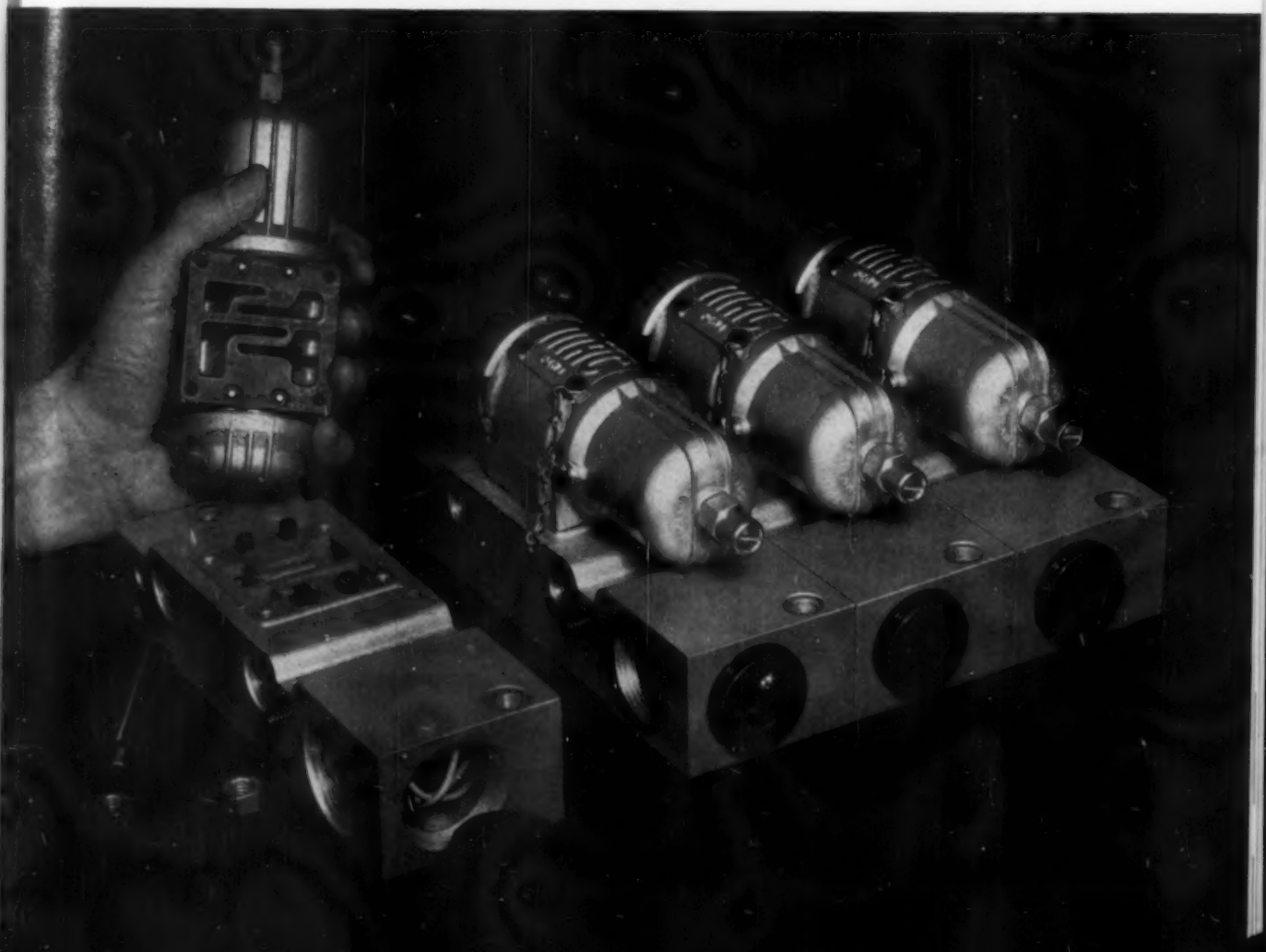
PRESIDENT

MECHANICAL AIR CONTROLS, INC.

10030 Capital, Oak Park, Detroit 37, Michigan

Export Representative: Ad Auriema, 85 Broad St., NYC 4

MAC



Now, at your service

jamesbury

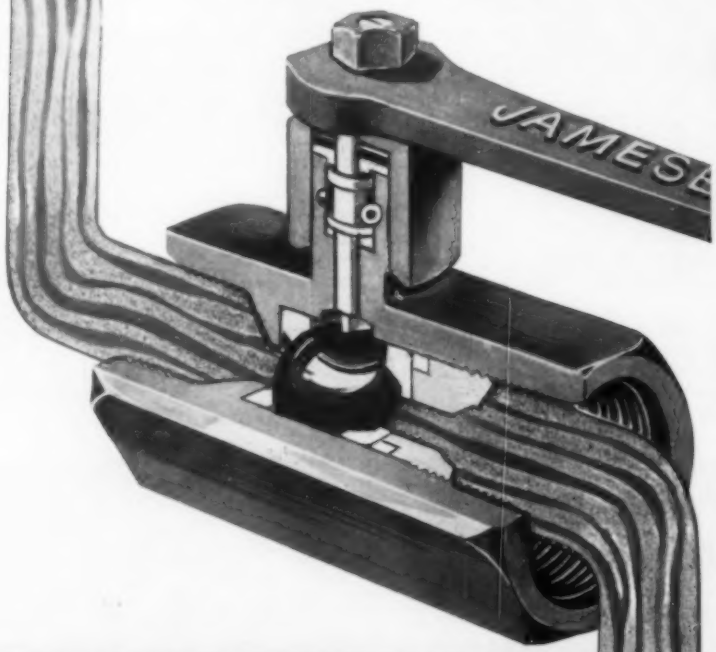
UNIT-BODY

"Double-Seal"™

HIGH-PRESSURE BALL VALVES

STYLE H SERIES

3,000-4,500 p.s.i. Range



. . . outstanding design newly available to industry

for
- **High-Pressure service**
- **High-Vacuum service**
- **Handling of hazardous fluids**
- **Cryogenic operations**

. . . no other valve has these outstanding features

- **Unit-body construction**
- **Positively leakproof**
- **Full-flow capacity**
- **Indestructible in service**
- **Corrosion-resistant**
- **Contamination-proof**
- **Incomparable size-rating-test-burst performance ratio**

—a newly developed and advanced valve design with broad industrial applications, available in eight sizes through 2", with 303 and 316 Stainless Steel or Carbon Steel bodies. Choice of nylon or "Teflon" seats and seals.

Distributors in principal cities.
For further information, write: Data: Style "H" Series

225-H

JAMESBURY CORP., 85 NEW STREET, WORCESTER, MASS.

Circle **84** on Time-Saver Card

NEW PRODUCTS

units in use, or complete filters with specifically-designed housings.

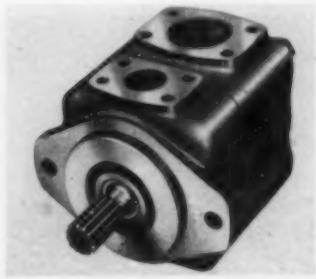
Specifications: Consists of two cylindrical sheets of Type 430 stainless steel. Drainage members, closures of Type 304 stainless. High permeability with pore size of 10 microns. Measures 1/16", has 10" o.d., 3" i.d. For wide temperature ranges, differential pressures over 200 psi.

Purolator Products, Inc.
Rahway, N. J.
Circle **314** on Time-Saver Card

VANE PUMP
. . . for mobile hydraulics

Designation: Series 45

Features: Increased hp. Pump housing holds any of three pumping cartridges, permitting easy change of delivery rate. All wearing parts are in a replaceable cartridge, replaceable in ten minutes for complete overhaul. Hydraulic

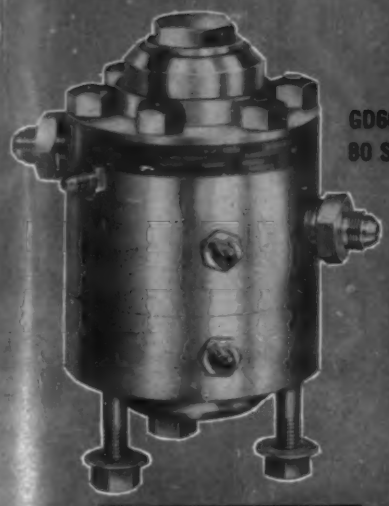


balance eliminates pressure induced bearing loads. Four-position cover adds installation convenience. Inlet can be rotated in 90° increments.

Specifications: For speeds to 2000 rpm, pressures to 2000 psi. Three models deliver 52, 63, and 75 gpm at top speed and pressure. At 1200 rpm, 100 psi delivery is 34, 41, and 48 gpm. Four-bolt SAE flange connections accommodate 2-bolt flanges.

Vickers Incorporated
Detroit, Mich.
Circle **315** on Time-Saver Card

For more NEW PRODUCT reviews turn to page 164



GD60 AND 80 SERIES

GD100 SERIES

LR20B SERIES

Control gases safely, accurately

TO 15,000 PSI AND 50,000 SCFM WITH VICTOR REGULATORS

You get precise regulation of high pressure gases with large flow rates, because Victor employs gas pressure to control the regulating diaphragm. The result is accurate delivery from 5 to 15,000 psi with inlet pressures to 15,000 psi . . . plus ability to obtain flows in excess of 50,000 scfm at maximum inlet and outlet pressures. Chart below shows operating range of standard models.

MODEL NO.	MAX. INLET PSI	MAX. OUTLET PSI	FEATURES	MAX. FLOW SCFM
GD10	3,600	500	Single adjustment regulator control	250
GD30	2,500	2,500	Load & bleed valve control	400
GD31	3,600	3,600	Load & bleed valve control	600
GD61C	2,500	2,500	Load & bleed valve control	170
GD62C	3,600	3,600	Load & bleed valve control	200
GD65	6,000	6,000	Load & bleed valve control	250
GD65C	7,000	7,000	Load & bleed valve control	250
GD80A	5,000	5,000	Load & bleed valve control	500
GD81A	10,000	10,000	Load & bleed valve control	800
GD86R	10,000	10,000	For remote control only	1,200
GD100R	6,000	6,000	For remote control only	20,000
GD100	6,000	6,000	Load & bleed valve control	20,000
GD200	6,000	6,000	Load & bleed valve control	50,000
GD700	7,000	7,000	Single adjustment regulator control; self relieving	250
SR10	3,600	1,000	Small, spring loaded regulator	4
LR20B	7,000	7,000	Spring loaded regulator; self relieving	2
LR20BSS	10,000	10,000	Spring loaded; stainless steel	2
LV10	7,000	7,000	Loader valve control	15
BPR10	7,000	7,000	Back pressure regulator	2

Operating temperature range: −67°F. to +250°F.

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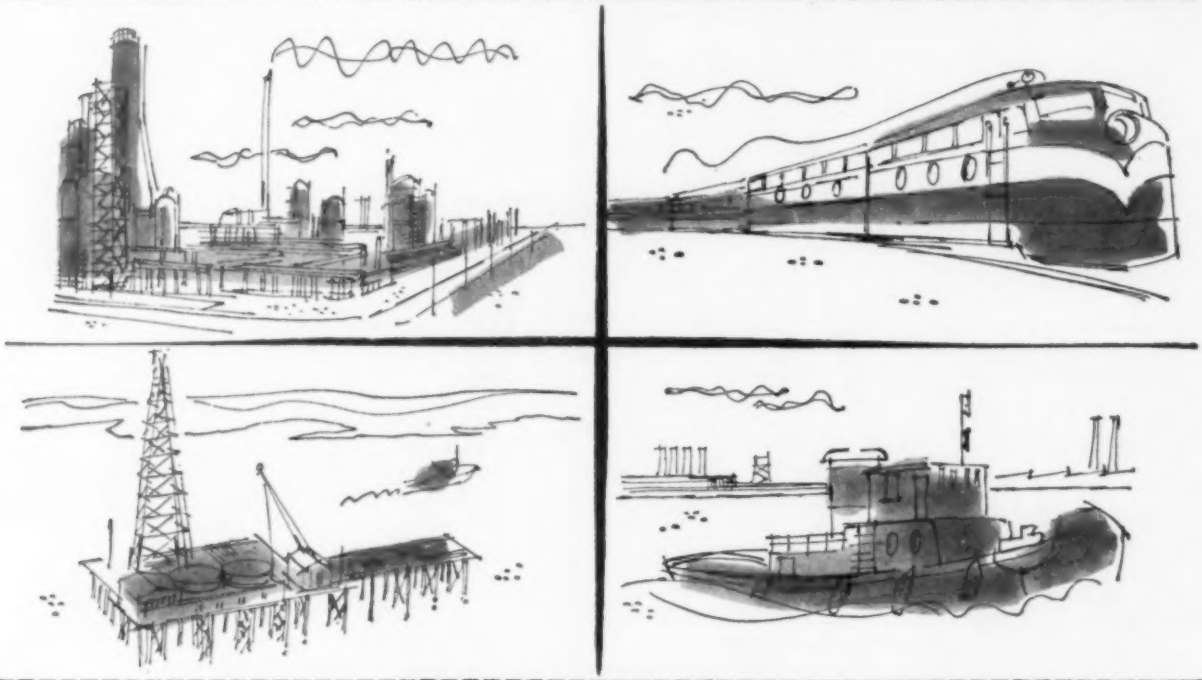

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Continued on page 78

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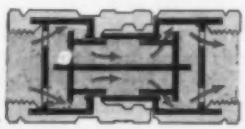

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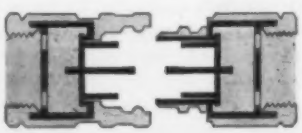

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PLASTIC TUBING

Described in combination bulletin and price list. General characteristics of Synflex —N3— tubing, including specifications. For air and hydraulic systems. *Synflex Products Division, Samuel Moore & Co., Mantua, Ohio.*

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For permanent application, leak-proof. Seals same in both directions, features microgrooves which allow rapid seating during initial cycling. Cutaway, label diagrams. Specification, wall thickness table. Price list. *Grover Piston Ring Co., Inc., Milwaukee.*

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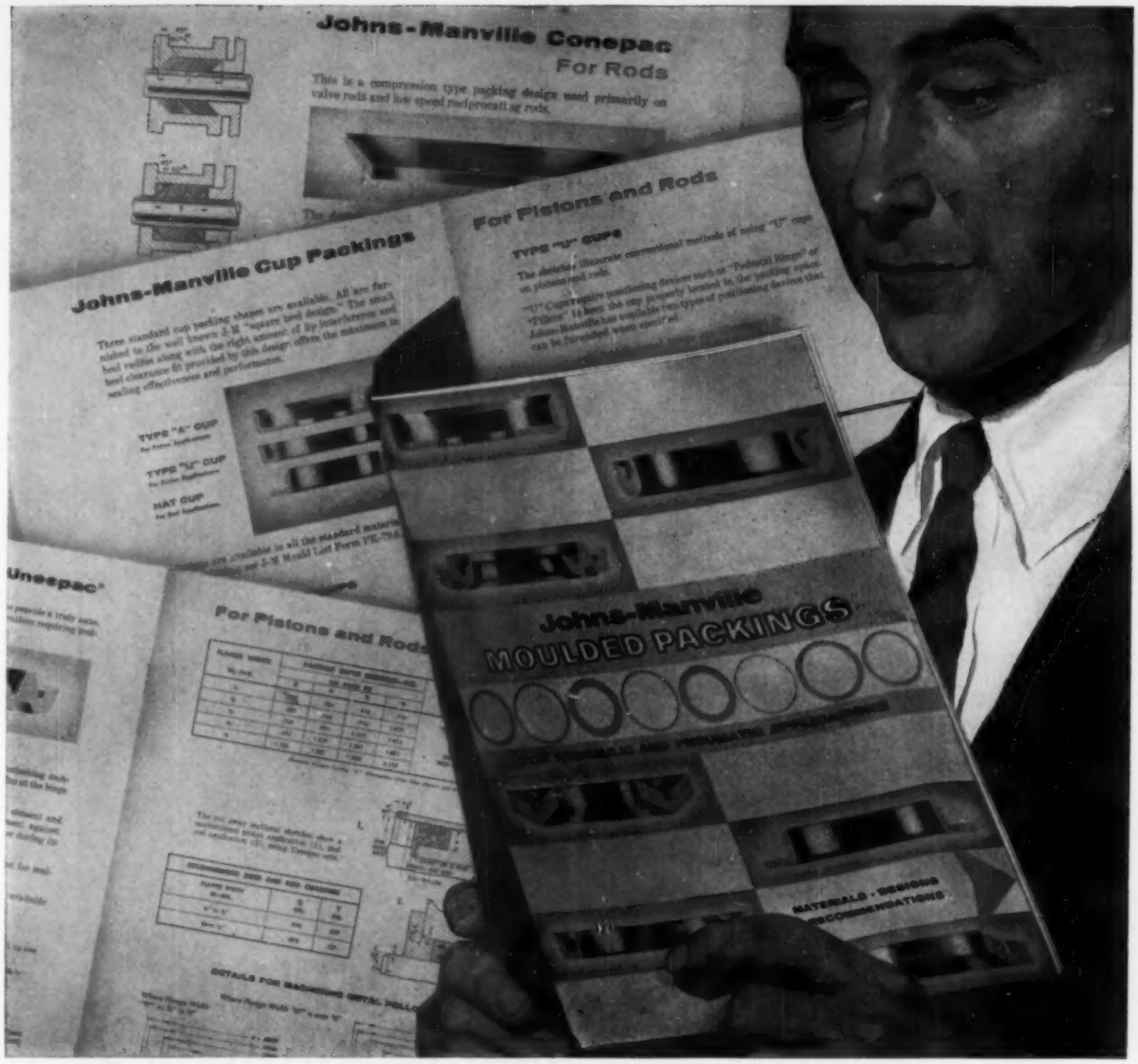

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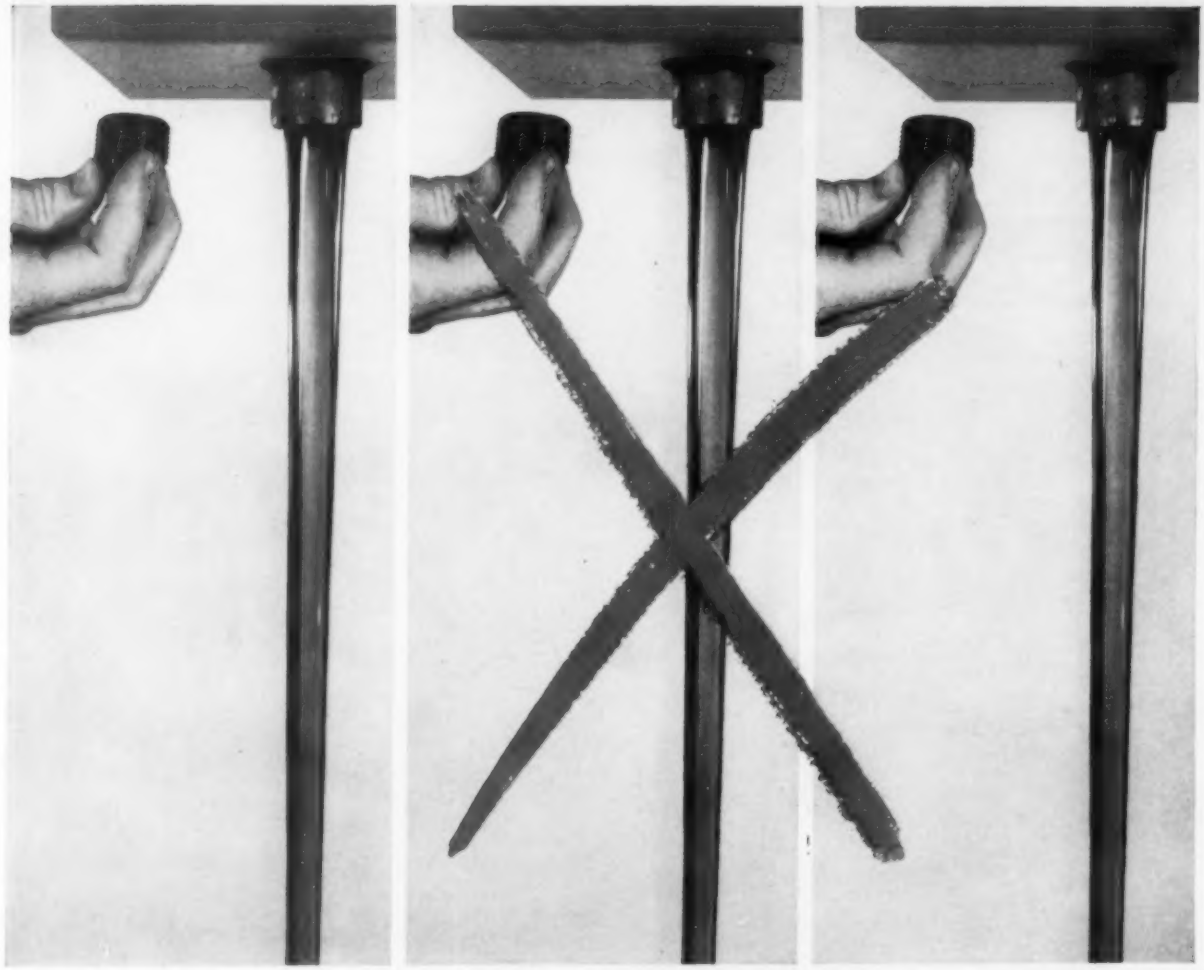

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APPLIED Hydraulics & Pneumatics
SEPTEMBER 1959

What's ahead in fluid power for space craft?

► *pump requirements*

► *high temperature fluids*

► *space APU sources*

► *reaction flight control*

future pump parameters

• By FRANK MLADINICH, *Group Leader, Hydraulic Systems, Grumman Aircraft Engineering Corp., Bethpage, L. I., N. Y.*

Can pump designers meet the challenge of future system demands? High temperatures, large flow rates, and rapid response requirements will tax present designs and materials.

TO date, pump manufacturers have kept abreast of advanced aircraft and missile fluid systems.

As pressures, temperatures and speeds increase, pump designers are challenged to create new materials and design concepts.

• **Temperature**—In the latest missiles, pumps must operate in ambient temperatures that approach 1000 F. The severest duty cycle is for ground-launched, long range missiles. Cryogenic propellents cool the hydraulic components to extremely low temperatures.

At engine ignition, the temperature climbs almost as fast as the missile. The pump must function effectively throughout this range.

Airborne short-range missiles must survive cold soak aboard an airplane. During its short firing period, temperature climbs rapidly. Miniaturization leaves no space for thermal insulation.

Small, ground-launched, short range missiles undergo the narrowest temperature changes. Because pump mass and bulk fluid provide heat sink properties, present pumps fulfill this requirement.

The pump designer must furnish pumps of high volumetric efficiency, with no external leakage, to operate over these wide temperature ranges. Elastomeric seals may not be used because of degradation at high temperatures. Bearings operating in 1000 F ambient and extreme speeds with little or no lubrication present further design and material problems.

• **Flow capacity**—Some missile systems require very high flow rates. Since space is limited, the obvious solution is to increase pump speed. This leads to many difficult design problems. The combination of high speed, high temperature, low lubricity fluid, and high loading, dictates relatively large bearing contact surfaces. This increases the size and weight of the pump. A bearing material with a high pressure loading capability is desired. It must also sustain impact loads, resist temperature and corrosion, and be machinable to lap-fit tolerances on a production-line basis.

Despite these limitations, small pumps for modest duty applications have been made for speeds as high as 60,000 rpm.

A high lubricity fluid would permit higher pump speed. However, for chemical reasons, extreme temperature stability and lubricity do not go together. This places the wear problem with the materials engineers of the pump manufacturers.

Pump response time to system demand is an important design factor. Accumulators can't be used on some missiles because of sensitivity to ambient temperatures and space limitations. The pump alone has to supply volumetric demands.

• **Higher efficiency**—Pump volumetric efficiency is based on very close-tolerance, lap fits of pistons, sleeves, and other internal parts. Since mating parts are often made of dissimilar metals, the difference in thermal coefficients of expansion will vary clearances and thus change leakage rates. A lower volumetric efficiency means that for a given flow requirement, the pump must rotate faster or the pistons be made larger. Leakage converts input horsepower to heat. The pump designer must balance these factors to arrive at a workable solution.

Some missile system specifications call for such diverse pump requirements as high g loading for acceleration, vibration over particular frequency ranges, and long storage.

The competition in providing energy and control systems is being intensified. Electrical systems, stored gas systems, hot gas systems are all being considered for these applications. Hydraulic systems provide predictable and reliable energy from a compact package with a good weight-to-horsepower ratio. As long as pumps can be made to meet increasingly severe requirements, hydraulics will continue as the chief source of secondary power for missiles. □□□

fluids to 1000 F

• By WILLIAM P. MAYHEW,
Staff Engineer, Advanced Fluid Systems,
Applied Research and Development, Republic Aviation Corp., Farmingdale, L.I., N.Y.

As missile ambient temperatures rise, new fluids must be created to service the power systems. A new 1000 F fluid is in development to fill the bill . . . it resists radiation too.

THREE of the most important characteristics blocking the development of high temperature fluids are bulk modulus, lubricity, and thermal stability.

As temperatures increase, bulk modulus becomes more important. A low bulk modulus causes excess fluid compressibility and spongy system response, resulting in flight control surface flutter.

The fluid must lubricate as well as transmit power.

Fluid lubricity decreases in the higher temperature range, wearing the pump's moving parts and decreasing its efficiency. Moving parts in other components may also seize or gall for lack of adequate lubrication.

A fluid with poor thermal stability may decompose or form deleterious products at high temperatures. These particles may clog filters, pumps, or servo valves.

As the speeds of advanced aircraft and missiles have increased, the operating temperatures of hydraulic systems have gone up too.

MIL-0-5606 has served the aircraft hydraulics field well. It has good viscosity characteristics in the —65 F to +160 F range, is a good lubricant, non-corrosive, and compatible with most elastomeric materials used in components. By excluding air in later systems, its operating temperature has reached +275 F.

A disiloxane base, synthetic fluid, called MLO-8515, currently used on supersonic aircraft systems, appears to have a +350 F operational peak. Its properties compare favorably with MIL-0-5606. MLO-8515 is 85% MLO-8200, a silicate ester (itself a 450 F fluid), and 15% diester to improve lubricity.

To exceed the 4550 F maximum of MLO-8200, much work has been done with silicone base fluids. A chlorophenyl methyl silicone has excellent viscosity-temperature properties and fair lubricity, but lacks sufficient thermal and oxidative stability and bulk modulus. Additives for correcting some of these deficiencies do not blend well with this fluid.

Mineral oils, silanes and esters show promise for temperatures in the 600 F range. A pump tested with MLO-7277 at 550 F and 3000 psi was in excellent condition after 50 hours. The main defect of this mineral oil was its inability to meet the —65 F requirement.

Re-entry vehicles, nuclear-powered aircraft and missiles will demand fluids that work at 1000 F. The only fluids which can meet this requirement today are liquid metals and polyphenyl ethers. Both of these fluids also have excellent radiation resistance.

Liquid metals are used as heat exchangers in nuclear reactors. NaK_{77}, a eutectic mixture of sodium (23%) and potassium (77%), is liquid from +14 F to +1443 F, has a very high bulk modulus and is readily available. Drawbacks are: highly corrosive, little or no lubricity, hazardous to personnel.

Polyphenyl ethers, originally developed as radiation-resistant engine lubricants have a possible temperature range of +15 to +1000 F. Thermal stability, oxidative stability, and bulk modulus are satisfactory, even at high temperature and a radiation dosage of 10^{11} ergs per gram of carbon. Republic Aviation has tested polyphenyl ethers for periods of 5 to 10 hours at 1000 F temperatures with good results.

Because a satisfactory 1000 F hydraulic fluid originally did not appear to be available, pneumatic systems seemed to be the logical approach to high temperature fluid power. However, systems employing gases such as air, nitrogen or hot gases must cope with problems of seal leakage and low bulk modulus. High temperature pneumatic components need extensive development before the industry can use them in high performance flight vehicles. In the meantime, hydraulic systems will continue to the most reliable high temperature fluid power for aircraft and missiles. □□□

accessory power for space vehicles

• By EUGENE T. RAYMOND, *Senior Group Engineer, Mechanical Systems*
Boeing Airplane Company, Seattle Division, Seattle, Washington

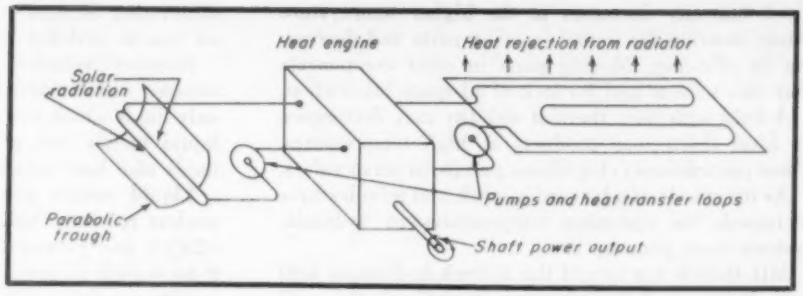
In future space vehicles, main engine power which is normally tapped to meet accessory power requirements will be generally unavailable. Therefore, independent self-contained power systems using either chemical, solar, or nuclear energy sources must be employed.

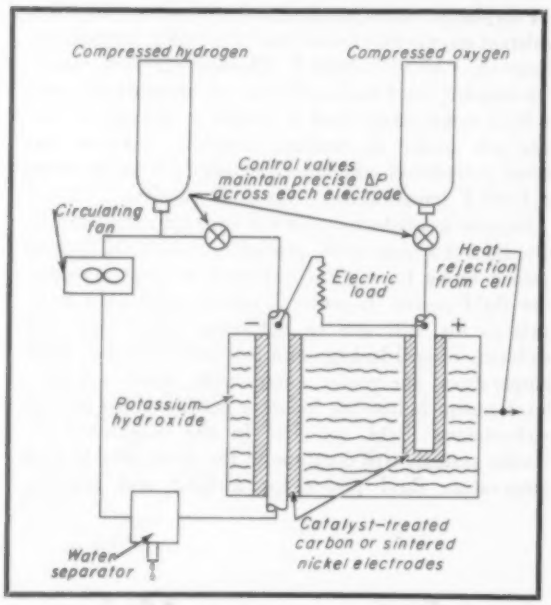
ACCESSORY or secondary power on a flight vehicle includes all power except that required for propulsion. It is required for control of vehicle attitude, direction, crew and equipment environment, and utility functions such as landing gear actuation and fuel pumping. Loss of accessory power can prevent a space craft from re-entering successfully. Secondary power then becomes of primary importance.

One of the main factors affecting choice of the power unit is vehicle flight duration. For short duration requirements (up to 2 or 3 weeks), chemically fueled APU's or electric fuel cells can be used. For longer durations, however, fuel consumption becomes excessive and solar or nuclear power units must be considered.

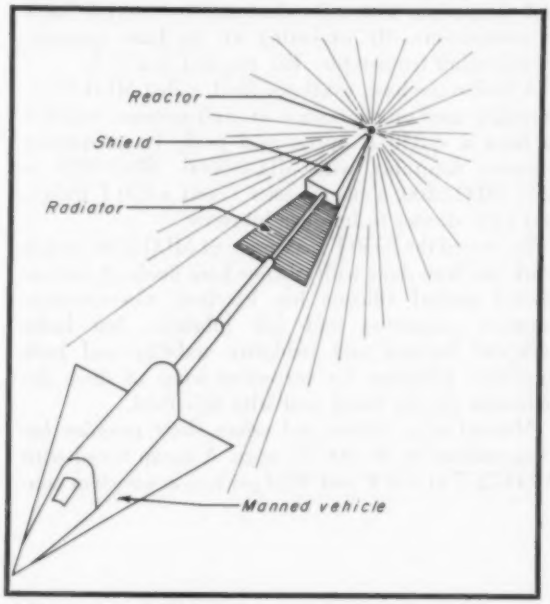
• **Chemically fueled APU**—Power units using solid, liquid, or cryogenic propellents are the best avail-

SOLAR ENERGY CONVERTER of the thermomechanical type, uses parabolic trough or dish. Flat plate or sphere collectors are covered with photoelectric converters.

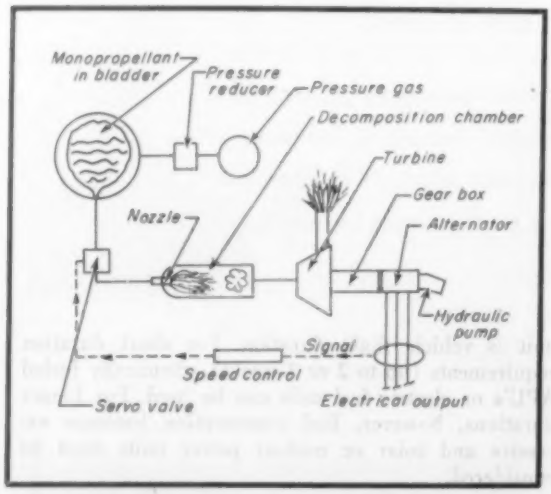




WATER FORMED IN FUEL CELL process is entrained in the hydrogen and must be separated.



NUCLEAR SHIELDING controls radiation only in the angle enclosing the manned vehicle. The heat sink radiator is in the shielded cone to protect the crew.



LIQUID MONOPROPELLENT decomposes spontaneously into a hot gas which drives the turbine. Hydraulic pump and alternator are driven from turbine gearbox.

able energy sources for systems operating from 30 minutes to several weeks. Hot gas from these sources is used to power turbine or reciprocating engine prime movers. Hot gas may also be used directly to pressurize hydraulic accumulators, hot gas servo systems, or reaction control rockets (used to maintain vehicle attitude in outer space).

Choice of a propellent depends on performance, logistics, ground handling, and storage reuirements. Longer operating time demands higher efficiency and lower fuel consumption.

• **Electric fuel cells**—Fuel cells are similar to batteries. They convert the chemical energy of fuel (hydrogen) and an oxidizer (oxygen) directly into electricity. Two basic types merit serious consideration:

a. The direct-acting type, in which gaseous H_2 and O_2 combine, d-c is current generated, and H_2O liberated.

b. The reduction and oxidation type, in which

electrolytes in the generating cell are regenerated by auxiliary reactions.

An advantage of fuel cells is higher overall efficiency (estimated 60%). Because of their lower propellent consumption in some applications, the cells may be better than chemical APU's for flight durations between two days and two weeks. Though complex, the fuel cells have few moving parts and potentially could be very reliable. They are not yet fully developed, however, and will be relatively heavy.

• **Solar power units**—Total radiant energy flux varies inversely with the square of the distance from the sun. On earth, this is 130 watts per square foot. Devices for utilizing solar energy include heat engines, and several types of direct thermal-to-electric and photon-to-electric converters. Heat engines and direct thermal converters require concentrators to properly focus the sun's rays and obtain the necessary high temperatures. (Radiators are also required to reject heat from the cycle). Devices utilizing photon energy require large surface collectors to capture the necessary amount of sunlight.

Four types of solar energy collectors or concentrators which are being considered are:

a. Parabolic dish; a highly efficient collector and concentrator, but needs a precise orientation mechanism.

b. Parabolic trough; sensitive in only one axis, thus needs simpler orientation system.

c. Flat plate, for collection only. Must be oriented, but it is not sensitive to angular error.

d. Sphere; needs no orientation when its surface is covered with silicon conversion units. It occupies four times the area of the flat plate.

Because of the weight and volume of this equipment, solar power units will probably be limited to power applications below 5 kw. When any solar power units are shaded from the sun, an alternate source (like a battery) is needed. Earth satellites at a 300-mile altitude may be in shadow for as long as 35 minutes of a 90-minute orbit.

• **Nuclear power units**—Nuclear power becomes the optimum energy source for vehicles with long flight times and higher power requirements. The power plant consists of the nuclear heat source, heat engine or thermoelectric converter, heat sink, shield, and controls.

The heat source would be a radioactive isotope or reactor; the engine would most likely be a Rankine-cycle turbine; and the heat sink a condenser-radiator. It can best be shielded by physically isolating the APU from the crew area. While in the atmosphere, however, an alternate power source must be used to reduce radiation hazard due to air or ground scattering of radiation particles.

• **APU vehicle integration**—In the case of the chemically fueled APU and the fuel cell, the integration problem is primarily to meet vehicle envelope dimensions. In high temperature areas, the heat sink capabilities of the fuel can possibly be used for cooling. Solar power units, with their erection, retraction, and orientation devices will require large storage space unless weight and size are kept to a bare minimum. Inflatable erectors and collectors may be one answer. Nuclear APU integration is mainly a problem in shielding and providing storage space for the necessary large condenser-radiator. Incorporating this component into the structure is a strong possibility.

In summation, it can be said that the best efforts of the fluid power industry will be needed to design systems and equipment to pressurize, transmit and control fuels, hot gases, thermodynamic working fluids, and liquid metals for these systems. □□□

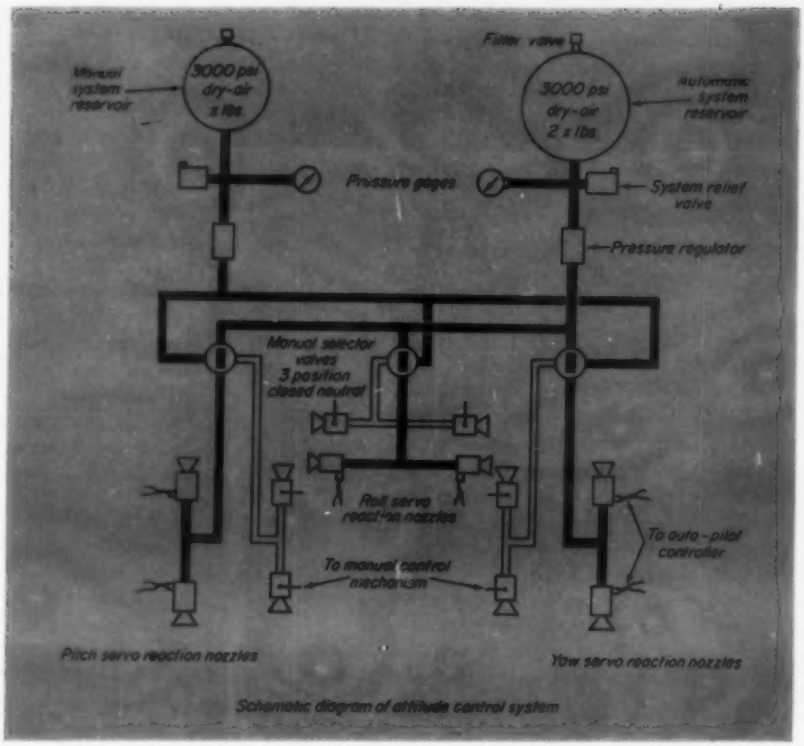
fluid power for the space pilot

• By WILFRED F. TALBOT,
Design Specialist
Norair Div. of Northrop Corp., Hawthorne, California.

How will the satellite pilot control his vehicle? A dual servo system uses compressed air for reaction jets.

WHEN a manned satellite is placed in orbit, its pilot has to control its altitude with respect to a plane of its orbit. The control motions are similar to that of an airplane in its pitch, roll and yaw axes. Reliability and simplicity are prime requisites.

Hydrazine, hydrogen peroxide and pressurized gases have been studied for possible use as fluid power media. Hydrazine has a higher weight-to-energy ratio than hydrogen peroxide which, in turn, exceeds that of air. Both fluids require catalysts for conversion



ORBITAL VEHICLE ATTITUDE CONTROL system uses reaction force of compressed air to maintain flight pattern. The reservoir for the automatic system has twice the capacity of the manual tank. Except for valve actuation, both systems are identical.

to usable hot gases. Hydrazine which is toxic in air needs careful handling. Hydrogen peroxide must be stored in a vessel pressurized by a high pressure, nitrogen-backed diaphragm and associated valving. A difficulty with liquified gases in space is that with the gas and the liquid in the same weightless condition they can become mixed and foul the system.

Though compressed air has relatively low energy, it makes satisfactory fluid for a medium-duration satellite. It is easy to handle on the ground, is not affected by reasonable temperature changes, and produces no heat.

For a satellite weighing 3000 pounds, from 0 to 7 pounds of force are required to control the roll axis, and 0 to 25 pounds for the pitch and yaw. As there are no natural damping means in space, over-control is a possibility, and the control forces must be accurately controlled.

The space vehicle flight control system shown here is both automatically and manually controlled. Compressed air is forced through six variable reaction nozzles, one pair acting in each of the three directional axes. The forces of each nozzle pair act in opposite directions to provide clockwise and counterclockwise moments. Although the manual and automatic systems are almost identical, they are each independent. Reaction forces in the automatic system are proportional to the current in the servo valve. Reaction forces in the manual system are proportional to valve displacement by the pilot. Each has its own supply of compressed dry air.

The pilot manually operates three control valves, selecting the automatic or manual system. If any automatically controlled axis malfunctions, the pilot can control that part of the system manually.

The most important factor in such a compressed air system is minimum leakage in the valves or other components. A pressure gage for each reservoir indicates remaining air supply. Relief valves protect the system from over-pressurization if exposed to excessive temperature.

□□□

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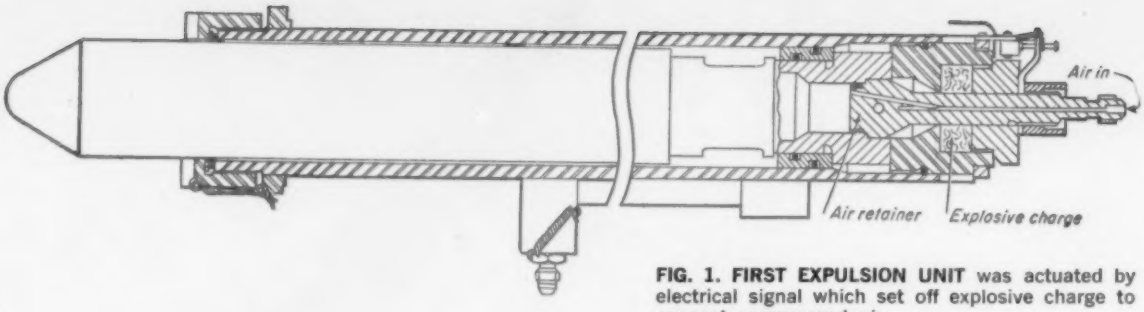


FIG. 1. FIRST EXPULSION UNIT was actuated by electrical signal which set off explosive charge to connect compressed air.

Pneumatics plays a big part in operation of a 200-mile missile which hits targets beyond the range of conventional artillery. Here's the development story on an actuator that sheds the burned-out thrust unit.

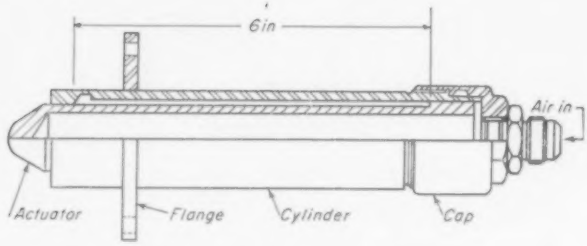


FIG. 2. FINAL UNIT based on revised calculations is much smaller, saves weight. Compressed air is always applied to the ram.

Air actuators separate thrust unit

AFTER a missile's thrust unit burns out, it must be separated from the missile which continues on in a ballistic path. This separation takes more than just detaching the two units, because they are traveling at the same speed and would remain together. The thrust unit must be *pushed* away. This creates a different drag on the thrust unit than the missile, so that they then separate.

Finding out how much force this takes and how far the force must act is a complex problem in aerodynamics using such factors as missile speed, and size. But the actuator finally developed is a simple, single-acting unit.

The first actuator which was designed for one application is shown in Figure 1. It was about twice the size of the later actuator which is based on revised calculations. When the thrust unit is detached, an electrical signal to the switch fires the explosive charge. This forces back an air retainer in the actuator, and compressed air is applied to the actuator ram. The area of the ram is approximately 3.76 sq. in., so that the force developed, with air at 575 psi, is 2200 lb.

The smaller actuator which gave considerable weight savings is shown in Figure 2. It has pressure air applied to its ram from the moment of launching. As soon as the bolts which fasten the thrust unit are sheared, the actuator forces the thrust unit away. The actuator is a simple piston-and-tube assembly with an air connection at the end. It has a ram area of 1.22 sq. in., so that it develops about 700 lb. thrust.

One of the design problems of the actuator was in sealing the air. Some of the methods which were tried were lip seals, and O-rings which were used with and without back-up rings. The solution was in getting the proper fit, and the dimensions of the groove and silicone rubber O-ring are shown in Figure 3.

The power source for the two expulsion units is a 3000-psi accumulator which supplies various pneumatic octuators in the missile at 585 psi through a pressure reducer. The expulsion units are connected into the system with ¼-inch tubing. □□□

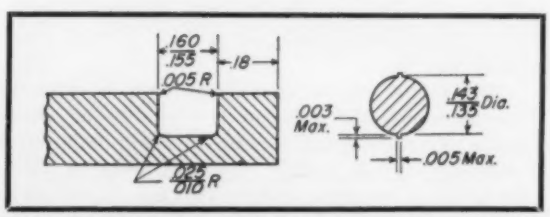
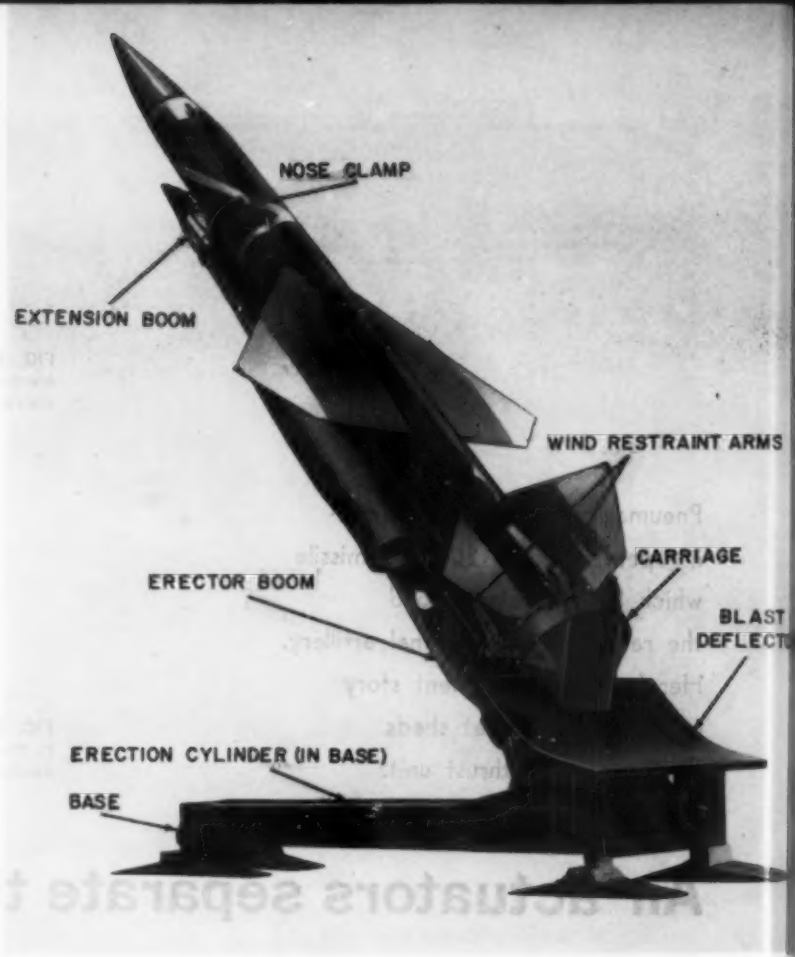


FIG. 3. AIR SEALING PROBLEM was solved by designing this O-ring installation.

To meet short-period energy demands of several hundred horsepower, this compact skid-mounted hydraulic system supplies power for all GSE operations.



Portable power skid for Bomarc launcher hydraulics

• By PETER J. CALCAGNO, *Section Mgr., Greenwich Engineering Division, American Machine & Foundry Co., Greenwich, Connecticut.*

STORED in a horizontal position in its shelter, the Bomarc missile must be raised to a 90 degree attitude prior to launching. The launcher-erector hydraulically supports, erects and launches the missile, as well as allowing for periodic ground maintenance. Power for these functions, as well as shelter door actuation is derived from a compact hydraulic power package capable of high performance within a very short time limit.

The main launcher-erector cylinder is trunnion-mounted with the rod end attached to the erector boom. Erection speed is controlled with a pressure-compensated flow control. Lowering speed is limited by a fixed, one-way orifice. Pressure compensation assures a fixed flow rate, independent of system pressure fluctuations and load changes. The erection cylinder has internal buffers at each end to minimize acceleration and deceleration forces imparted to the missile. A zero-position external buffer absorbs energy when the boom is lowered to the horizontal while loaded with a missile.

• **Power package**—This unit consists of four sections:

Pump and reservoir
Accumulators
Control valves and manifold
Control panel and instrumentation

The base of the package forms the reservoir with level gage, relief valve, filler/breather, check valves and filters mounted nearby. A 9-gpm pump driven

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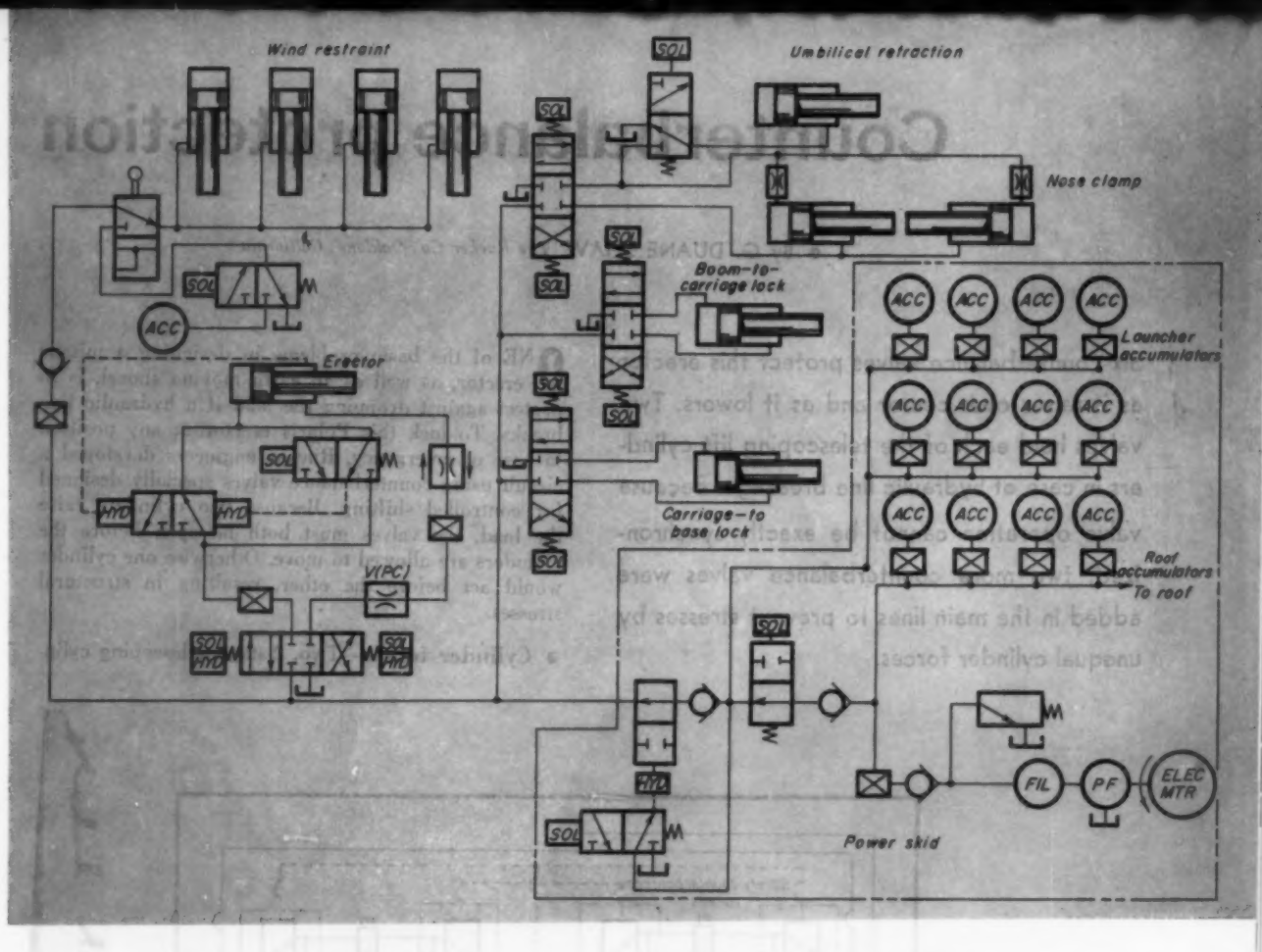
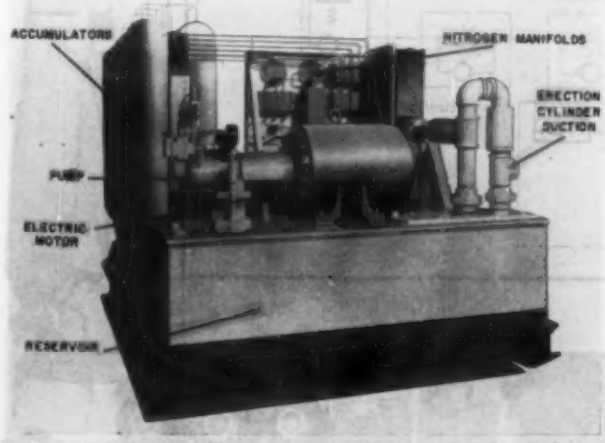
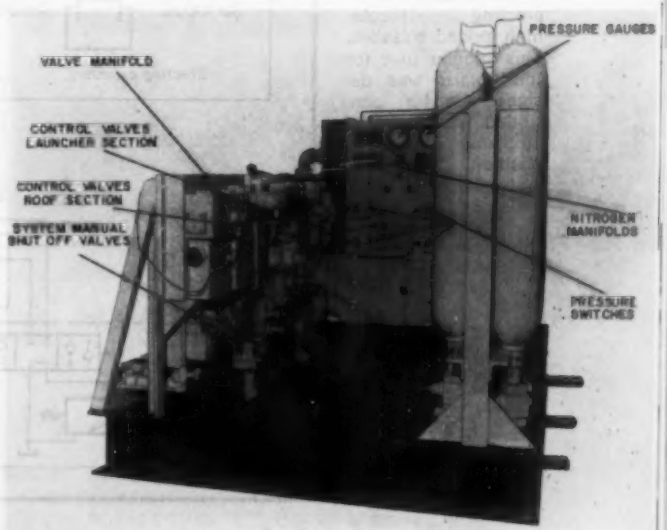


GROUND SUPPORT HYDRAULIC CIRCUIT shows the relationship of the erector-launcher functions. Individual shutoff valves eliminate any function without affecting others.



REAR VIEW OF POWER SKID shows power source and the accumulator banks from which fluid is distributed to the various ground support functions during the launch cycle.



CONTROL AREA OF THE PACKAGE is seen in this front view. Floor area in center is for access to manifolds and shut off valving. Accumulators may be cut out of the system individually without impairing operation.

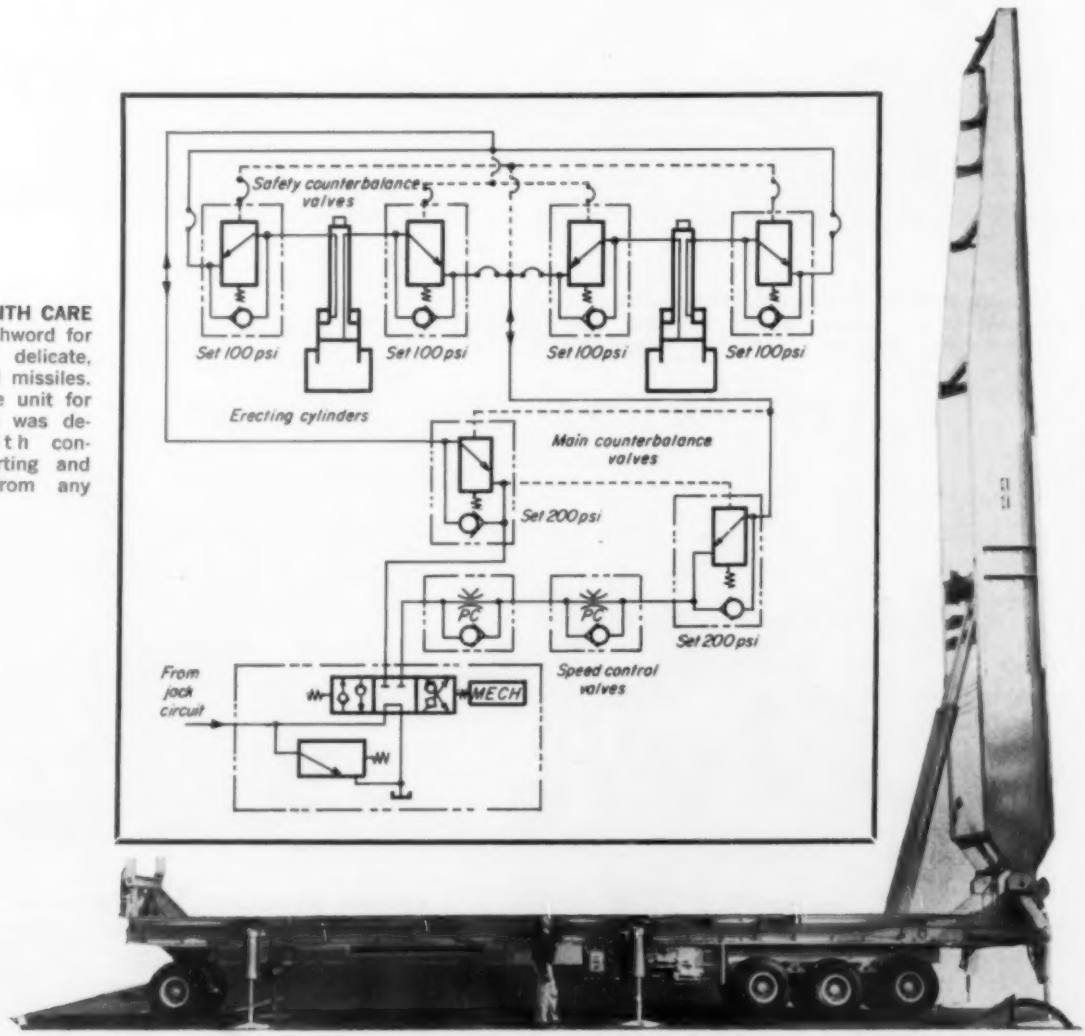
Counterbalance protection

• By G. DUANE SHAW, *The Rucker Co., Oakland, California*

Six counterbalance valves protect this erector as it raises over center and as it lowers. Two valves hold each of the telescoping lift cylinders in case of hydraulic line breakage. Because valve operation cannot be exactly synchronized, two more counterbalance valves were added in the main lines to prevent stresses by unequal cylinder forces.

ONE of the basic problems in designing a missile erector, as well as an earth-moving shovel, is to protect against dropping the load if a hydraulic line breaks. To lock this Polaris erector at any position in case of emergency, Rucker engineers developed a circuit using counterbalance valves specially designed for controlled shifting. Because two cylinders raise the load, the valves must both be open before the cylinders are allowed to move. Otherwise one cylinder would act before the other, resulting in structural stresses.

• **Cylinder forces**—Two, 2-stage, telescoping cylin-



HANDLE WITH CARE is the watchword for erecting delicate, high priced missiles. This mobile unit for the Polaris was designed with controlled starting and stopping from any position.

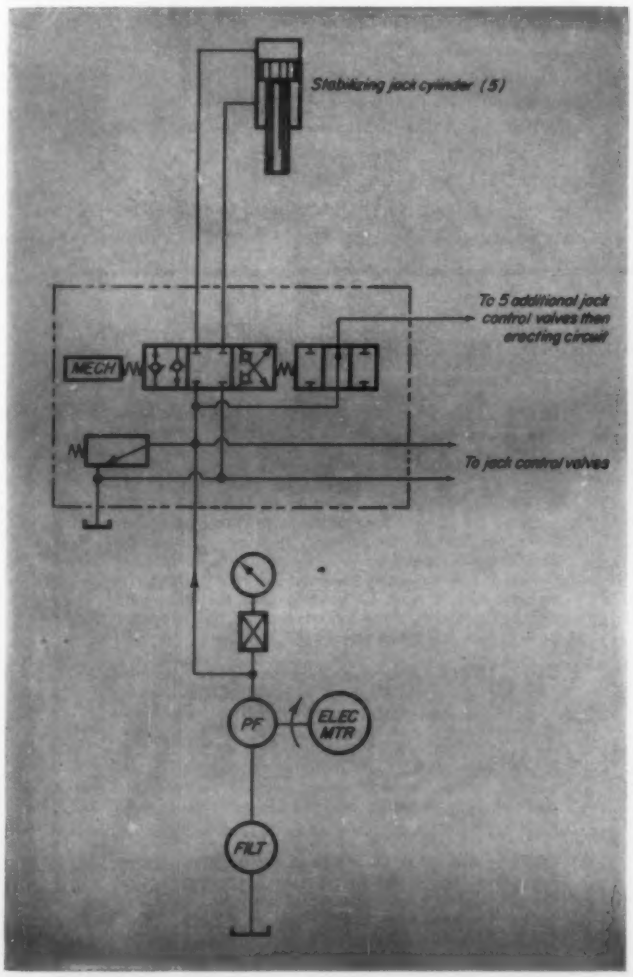
for Polaris erector

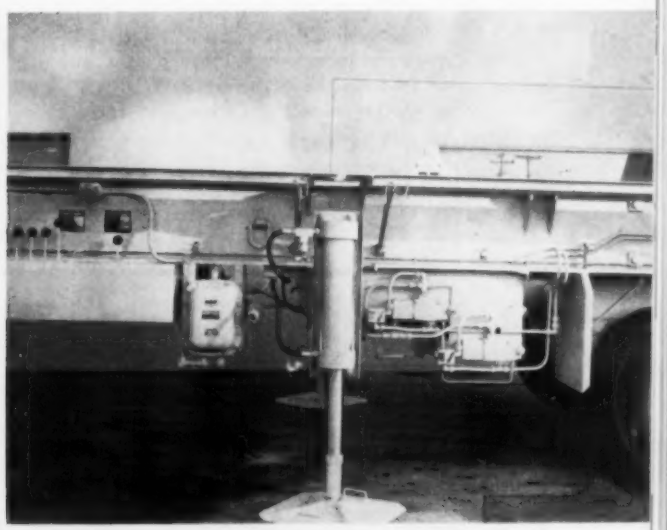
ders raise the erector over center. Each of these has a first-stage, ram type cylinder and a second stage, double acting cylinder. This double acting stage permits pulling the load back over center during lowering from erected position.

The 8½-inch single-acting stage moves first through an 85-inch stroke. The cylinders work on an effective lever arm of 99 inches and produce a torque of 1,170,000 lb-ft at 1250 psi.

At the end of the first-stage stroke, the 7½-inch double acting cylinders exert 900,000 lb-ft torque on the boom. Peak force is required when the second stage cylinders begin to extend. Stroke of the second stage is mechanically limited to 57½ inches. To pull the boom back from its over-center position, the second stage retracts, exerting a torque of 314,000 lb-ft on the boom, at the point of first movement from the fully erected position. When the second stage is fully retracted, the load is well across center, and the boom lowers by gravity.

• **Valve mounting**—Since the counterbalance valves protect against line breaks, they should be mounted as close as possible to the cylinder. Then only a rup-





SIX JACKING CYLINDERS lift the vehicle during erection. They are controlled individually by a 6-spool, manual valve (control panel at left) or together by one lever which shifts all spools at once.

VALVE CONTROLLING JACKING CYLINDERS has six spools in one body casting, plus an integral relief valve. Parallel connection permits operating one or more cylinders at once. Fluid is directed to erecting circuit only when jacks are locked in position by the closed-center directional valves.

ture between the valve and the cylinder causes uncontrolled cylinder movement. The valves are mounted adjacent to the cylinder rod. Line mounted valves are used, with the shortest possible length of pipe connecting them to the cylinder port. To locate all hydraulic lines at the same end of the cylinder, they pass through the cylinder rod. At a slightly higher cost, the valves could be sub-plate mounted on a machined flat surface on the side of the cylinder.

• **Protective valve operation**—When flow is directed to extend the cylinders, it bypasses the down-acting counter-balance valves through check valves. When the second stage starts to extend, discharge fluid from the rod end must pass through a counterbalance valve. The pilot line for this valve is connected into the pressure line. Since pressure required to lift the boom is well above the 100-psi setting of the counterbalance valve, the valve is open and passes fluid freely.

To retract the cylinders, fluid passes through the bypass checks to the rod ends of the second stage cylinders. Pressure again holds the other set of counterbalance valves open for free fluid flow.

If a line breaks, pilot pressure which has been holding the counterbalance valves open is lost and the valves close to lock the cylinders in position. With two counterbalance valves for each cylinder, the boom is locked on either side of its center position.

• **Cylinder synchronizing**—Theoretically, connecting the two cylinders and their protective counterbalance valves in parallel permits dual operation. Practically, however, the valves cannot be made to operate simultaneously. This would give a momentary situation where one cylinder would extend while the other is still blocked, and would result in structural deflections and loss of cylinder synchronization. Because of manufacturing tolerances, the valves do not operate at exactly the same pilot pressure, do not

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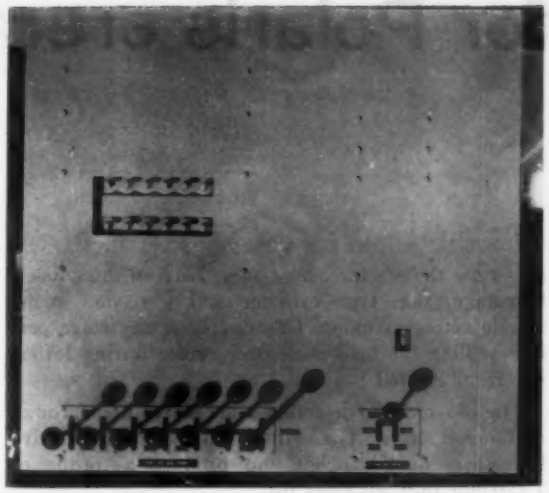

CONTROL PANEL has six levers for individual jack control, master lever for control of all jacks at once. Elevation control (right) rides in an inverted U-slot. Moving the control to either side shifts the directional valve. The flow controls remain closed until the lever is moved down.

10 FACTORS IN DESIGNING GROUND SERVICE EQUIPMENT

1. MOBILE OR FIXED EQUIPMENT—A mobile erector is frequently used for test phases, a fixed or stationary installation for operational use. The mobile erector must have either a self-contained source of mechanical power to operate the hydraulic system or a source of electrical power which can be connected to the erector at the launching pad.
2. WEIGHT—Always a factor in designing mobile erectors, it may also be significant with fixed units which must be dismantled for transfer to another site.
3. OVER-ALL DIMENSIONS—The main cylinder is often the critical hydraulic element in keeping envelope size within limits.
4. HIGH FORCES IN SMALL VOLUMES—Hydraulics is at a distinct advantage. Its merit in this respect keeps down weight and size.
5. FLEXIBILITY, MULTIPLE OPERATIONS—Missile handling equipment frequently has to be modified during development. Also the power source may have to supply different operations. It may be possible to design reserve capacity in one or more of the system components.
6. CONTROL—Missile erectors usually require variable angular velocity. Speeds may be high, but require smooth acceleration and deceleration. Fail-safe operation is required.
7. LOW G LOADING—A missile may be very delicate when lying on its side prior to being loaded and fueled. The missile may be able to withstand high g loadings in flight but extremely vulnerable while being handled on the ground. On some missiles, the skin is highly stressed when the missile is operational, because interior compartments are pressurized for rigidity. Also it must be handled with low g loadings on the ground because of connections for electrical power, fuel, instrumentation, etc.
8. DUTY CYCLE—The equipment should be designed only for operation which is intended. Careful evaluation of the requirements results in better performance at lower cost.
9. ENVIRONMENTAL CONDITIONS—Where the equipment must operate determines design requirements. Hydraulic equipment is available for extreme environmental conditions.
10. COST—Low cost is the result of avoiding over-design. Too often, the specification tries to protect against things which happen very seldom, and calls for design far above what is practical.

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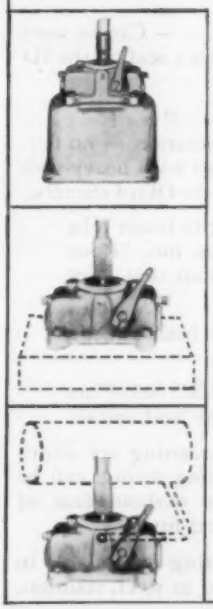
Hand Pump Performance Data

Model Number	Piston Dia.	Delivery Per Stroke (cu. in.)	Required Force (lbs.) on Pump Handle at Various Circuit Pressures (psi)					
			1000 psi	1500 psi	2000 psi	3000 psi	4000 psi	5000 psi
B301	9/16"	.2485	16	24	32	48	64	80
B304	3/4"	.4418	28	42	56	84	—	—
B307	1-5/16"	.6903	44	66	88	—	—	—
B309	1-5/16"	1.353	88	—	—	—	—	—

3 Types of Pumps Tailored to Your Installation Requirements



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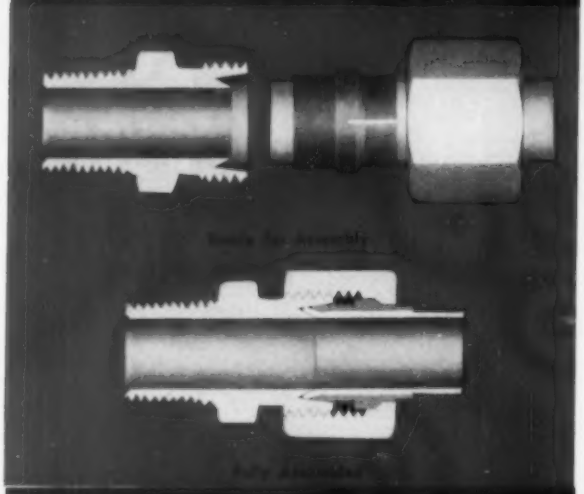

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COUNTERBALANCE PROTECTION FOR POLARIS

Concluded from page 92

shift at exactly the same rate, and do not have the same flow characteristics. Even if it were possible to obtain matched valves, variations in spring fatigue, maintenance changes, and wear differences would unbalance them.

Rather than attempt to synchronize operation of the safety counterbalance valves, two more counterbalance valves were added in the lines from the 4-way directional valve. Each of these is pilot-operated by pressure in the opposite line. They are set at 200 psi. When the directional valve is shifted, pressure must build to 200 psi before the exhaust line from the cylinders opens and the cylinders can move. Since the safety counterbalance valves are set at 100 psi, they are open whenever the cylinders can move. It is impossible to impose loads which would deflect the structure or get the cylinders out of synchronization.

• **Valve spool design**—In the operation of large missile erector systems, another important counterbalance requirement must be met. A counterbalance valve must throttle fluid as it opens and closes, and it must have controlled shifting. Standard industrial and aircraft counterbalance valves were unsatisfactory for this job. While they can control cylinder speeds so that variations cannot be detected by eye, missile erectors have design requirements far in excess of common industrial applications.

Because of the extremely short lever arm compared with the overall length of the boom, small variations in cylinder speed are magnified at the end of the boom. Because the boom must be light, it is also flexible, and deflects at relatively low speed variations. It can easily become a spring-mass system which amplifies any speed variations, so that erection or lowering must be stopped to prevent damage. Control with standard valves is too abrupt. The valve spool moves from full open to full closed too fast.

Valves designed for this application have special spools and close control of shifting speed.

The spool travels a relatively long distance in shifting. Rather than tapered lands which give poor control from fully closed to low metered flow, the valve has a hollow spool. Oil is metered through small holes drilled through the spool in a spiral pattern. With proper linear spacing of the holes, flow area varies linearly with spool displacement.

Spool shifting is controlled by a throttling orifice and a pilot control head. Together with the larger diameter of the spool design, this gives excellent damping of spool shifting. Damping can be varied to adjust spool speed.

• **Speed control**—Variable speed, both manual and automatic was required for erection and lowering. Since a variable volume pump would be too expensive, speed control has to be by valving.

Flow control valves are connected to meter flow to the cyinders during erection, and flow out during

lowering. This arrangement controls speed through the full boom travel in both directions.

The pressure-compensated flow control valves have both manual and program control. A program cam positioned by the boom actuates the valves to limit maximum speed according to boom position. The valves can also be controlled manually to obtain boom speed from zero to the limit permitted by the program cam. It is impossible for the operator to overspeed the boom. A programmer also controls acceleration and deceleration at the extreme ends of the cycle.

• **Directional control**—A 3-position directional valve controls raising, lowering, and stopping the boom. The flow control valves are mechanically interlocked with the manually operated directional valve so that they are closed with the valve in the neutral position. The cylinders can be stopped by four methods: a. flow control valves, b. closed center directional valve, c. safety counterbalance valves, and d. main counterbalance valves.

All controls had to be of the *dead man* type. This is done with spring-loaded valves controlling the jacks and the boom. Because of the controlled deceleration required, even in an emergency stop, the boom directional control valve had to be damped so it would return to neutral at a slow enough rate. The damping also prevents accidental over-acceleration by limiting the rate at which the flow control valves can be moved from zero to full open. □□□

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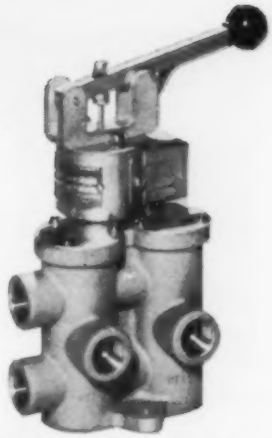

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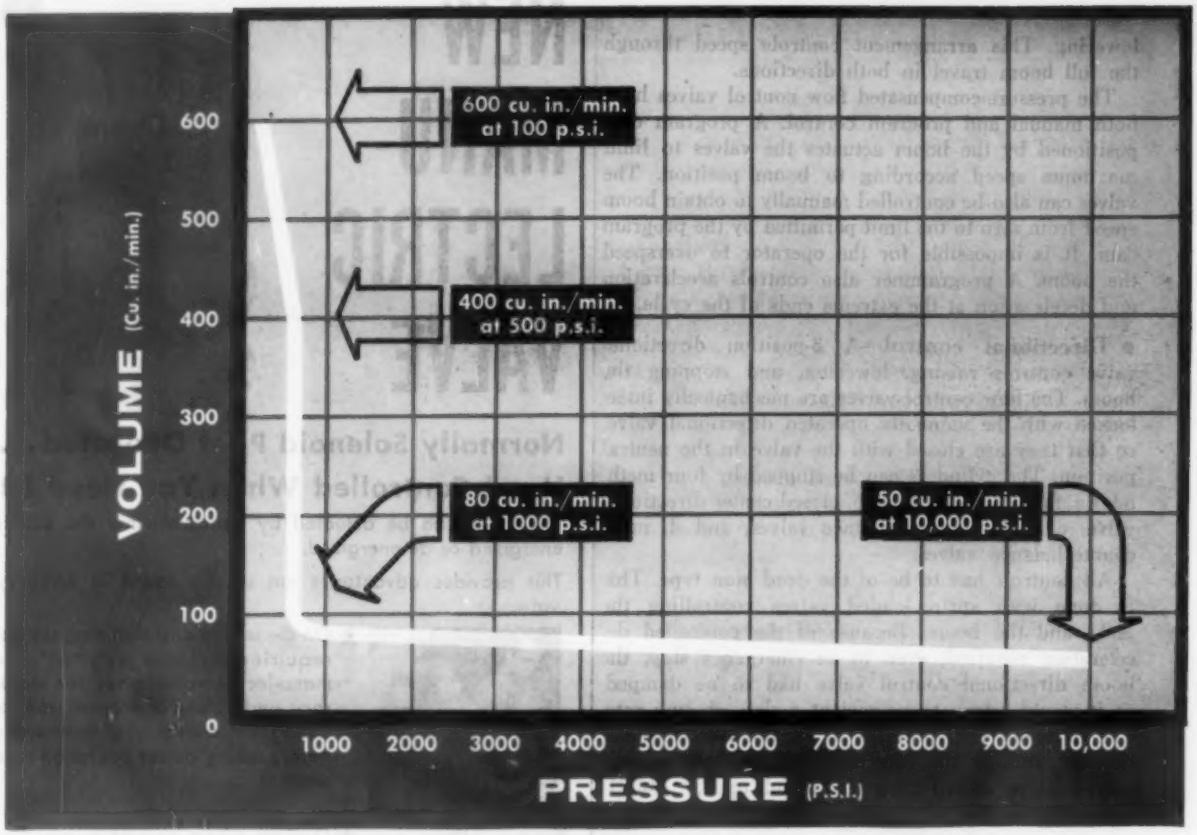

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PRECISION HYDRAULICS DIVISION

OWATONNA TOOL COMPANY

710 N. Cedar Street, Owatonna, Minnesota

High frequency vibration tests need fast servovalves

• By LEE W. G. BEYDLER, *Design Specialist* and WM. W. McDOWELL, *Instrumentation Supervisor, Norair Division, Northrop Corp., Hawthorne, Calif.*

THE vibration tester for the Snark missile ground service equipment produces frequencies from 2 to 500 cps, at strokes to 6½ inches. Since some of the test specimens weigh 2 tons, the tester was designed for peak block forces of 100,000 pounds.

In previous vibration testers, the specimen was suspended by springs and a single actuator vibrated it. Control was poor and transmission losses high.

Northrop engineers designed a multiple point input system to cover the full range of frequency and amplitude. Four sets of servo-controlled hydraulic actuators grip and vibrate the specimen. The actuators have an 8 sq. in. piston area and a 7-inch stroke.

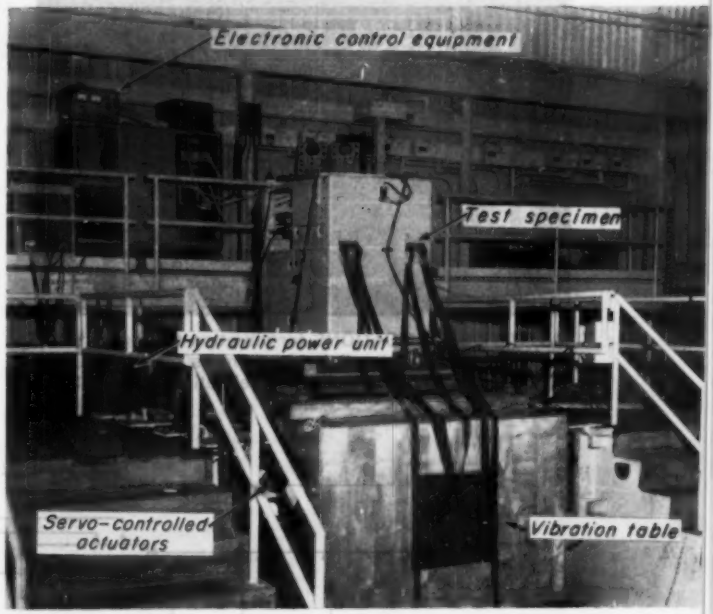
• **Servo valve design**—One of the most difficult phases of the project was designing the control system. There were no standard servo valves available which would meet the circuit requirements. It was necessary to develop a valve specifically for the system.

The valve had to operate at 1000 cps with reduced output above that point. Its flow was to be 60 gpm with no packing and no leakage.

The design is basically a 2-stage electro-hydraulic servo valve. The pilot valve is a small, 4-way, closed-center spool, driven by a voice coil. This design is not as linear as a moving vane, but it permits a much wider swing in differential pressure. The tiny pilot valve spool has a total travel of ±.003 inches.

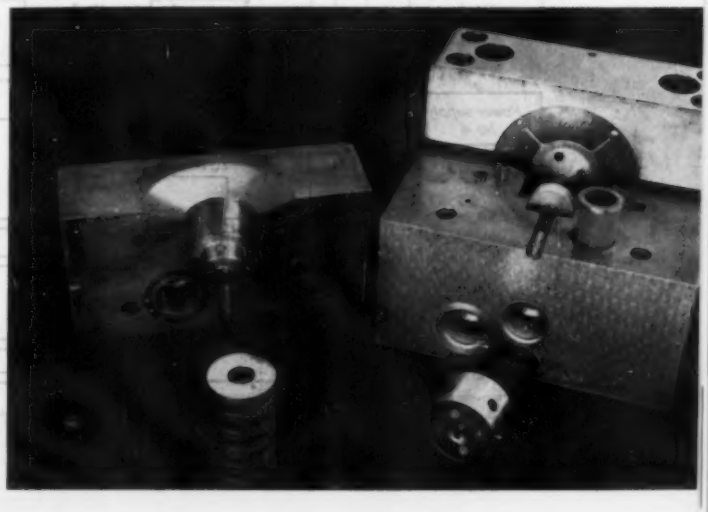
Pilot valve output (differential pressure) is applied to the main spool. However, pressure is applied to a gain changer piston, of smaller diameter than the main spool.

Optimum gain change ratio of the gain change piston occurs when losses due to fluid flow are equal to losses in driving the inertia load. If enough oil were to be supplied by the pilot valve to drive the main spool directly at the required velocity, then the pilot spool would have to be much larger. By applying pilot flow to a smaller area, the required main spool velocity can be attained. Carried to the extreme (a very small area) velocity would be very high, but available force would be insufficient to overcome inertia load of the main spool. Therefore, an optimum area was calculated where maximum velocity was commensurate with required forces.



VIBRATION TABLE in its operating position between the two sets of actuators. A hydraulic ram lifts the table for access to the actuators. Test specimens weighing up to 4000 pounds can be tested on the machine.

ELECTROHYDRAULIC SERVO VALVE shows pilot valve cap and main spool and sleeve at left. Pilot spool and housing is at right. Voice coil driver is within spider spring.

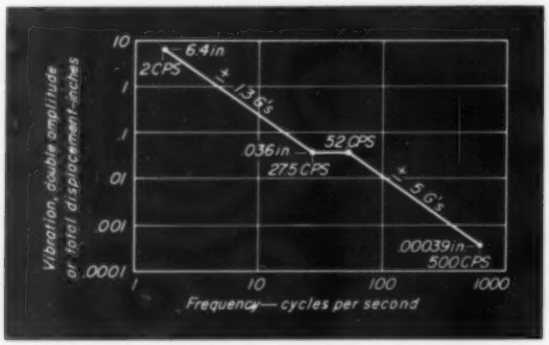


HIGH FREQUENCY VIBRATION TESTS

The optimum gain change ratio was calculated from the pilot spool flow rate, the oil-column spring rate, and the mass of the main spool and gain change pistons. To reduce the mass of the main spool, considerable metal was removed. The finished spool resembles a short hollow cylinder with a number of large fins.

The main spool is constructed with what are essentially turbine blades. They offset the Bernoulli centering forces by supplying an equal and opposite, axial de-centering force. The blades are a conical section on the spool minor diameter and are slotted at 45° to the spool centerline. The slots provide an angular torque which rotates the spool when fluid flows. This prevents any slight dead band in the main spool travel.

A 2-micron, built-in filter supplies clean oil to the pilot stage and to a small (½-gpm) jet pump. The jet pump takes leakage from two scavenge glands at the pilot spool, and discharges the oil to the system return lines. Since the pilot stage has no packing, valve leakage indicates jet pump failure.

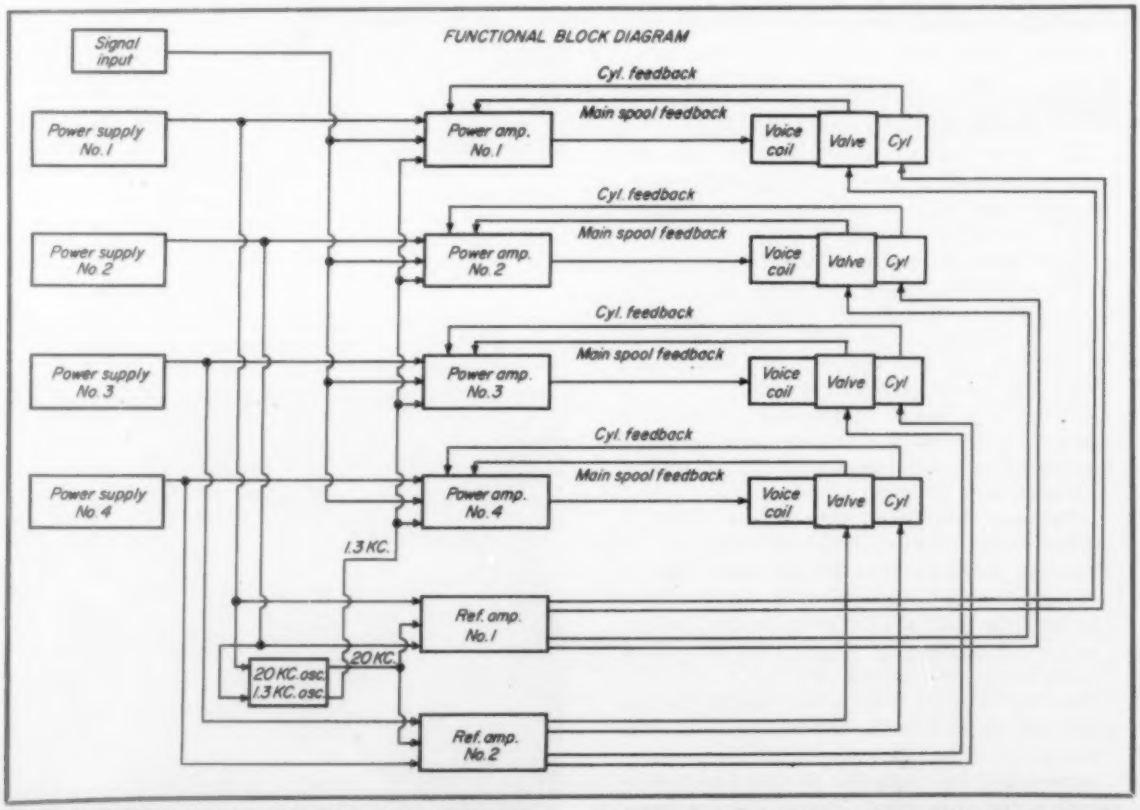


MILITARY SPECIFICATIONS for vibration testing of transportation equipment call for frequencies of 2 to 500 cps with strokes to 6.4 inches. Acceleration in the lower amplitude ranges is ±5 g's.

• **Hydraulic power supply**—A 108-gpm, 3000-psi pump driven by a 200-hp electric motor provides the hydraulic power for the system. The circuit has five, 10-gallon accumulators manifolded to the main pressure line. They store oil for peak flows above the capacity of the pump. In case of malfunction, the pressure can be released and the oil unloaded to the reservoir through a balanced relief valve. The unloading signal can be manual or automatic, through any one of several interlocks.

• **Performance**—While the system was designed for sinusoidal vibration, tests show that it will also accept random inputs. The valve and actuator response ranges above 1000 cps. Consequently, the machine may be used for space-age environments also. □□□

Northrop's developments in the vibration equipment field are being produced and sold under license by Wyle Mfg. Corp., El Segundo, Calif.



CONTROL SYSTEM consists of four identical circuits electronically synchronized. System No. 1 is the master and the other three are slaves. Synchronizing is done by detecting any error between two systems and summing it into one of the systems, forcing it to be a slave to the other.

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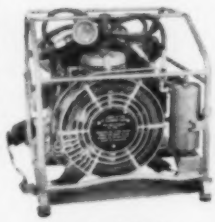
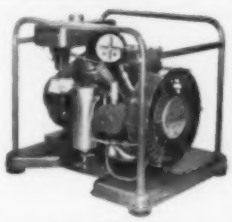
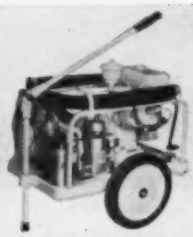


Model 3260101
3.5 SCFM — 2000 psi



Model 3750303
3.5 SCFM — 3000 psi



Model 130R1409
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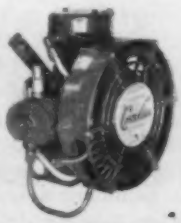

Model 3800100
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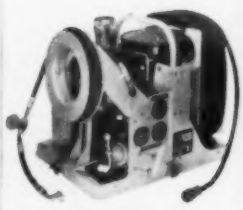

Model 130R3500
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Cornelius ground support air compressors are light enough to be handled by one man but don't let their small size deceive you! When it comes to performance they provide pressures up to 3000 psi and air delivery up to 4 SCFM. Cornelius compressors can often be wheeled into service and complete jobs faster and easier than motorized equipment. They are ideal for "retriever" service because they are easily and economically flown to stranded aircraft.

A complete Cornelius ground support service system includes compressor, moisture separator, oil filter, inlet filter, relief valve, pressure gauge and high pressure hose. Pressure reservoirs, back pressure valve, pressure regulators and chemical driers are optional. Gasoline engine drive, hydraulic or electric motor drive as well as turbine drive can be used to power Cornelius equipment. All U. S. military services use Cornelius compressors. Aircraft, missile, flame thrower and underwater demolition support are a few of their current applications.

Cornelius also manufactures compressors only, for mounting on your own multi-purpose ground support carts. In addition, a complete line of small industrial compressors (up to 3000 psi discharge pressure) for OEM, lab work, production test work and maintenance are available.

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Pioneers in pneumatic systems for aircraft.

Hydraulic Power for short duration missiles

• By H. J. HOWARD and R. W. McJONES, *Preliminary Design Group, Vickers, Inc., Div. of Sperry Rand Corp., Torrance, California*

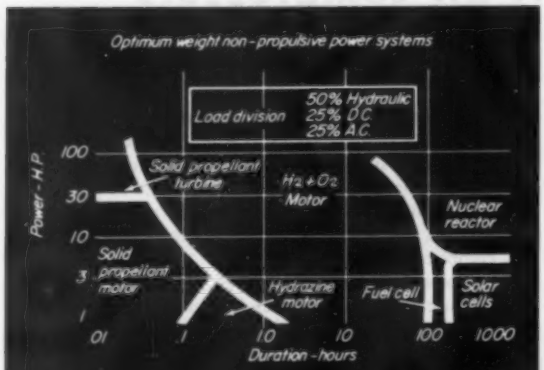


Figure 1

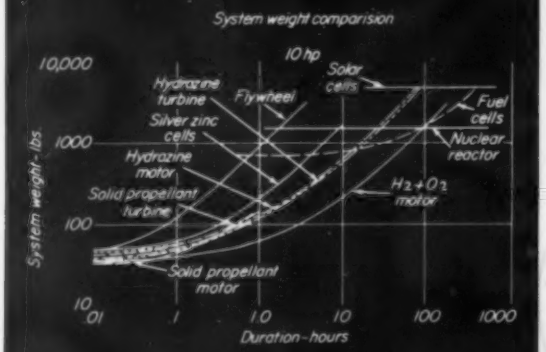


Figure 2

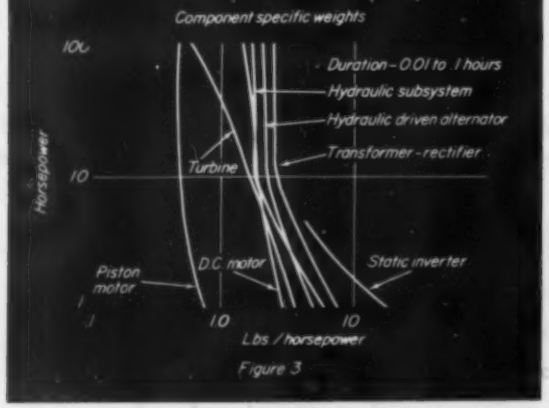


Figure 3

THE mission for some of our future air vehicles is so dependent on the power to operate components within the vehicle that the auxiliary power system is fast becoming a key to future air weapon systems. Missile hydraulic power actuates flight control surfaces, nozzles, and numerous other devices, and drives alternators and generators for electrical power. The auxiliary power of a few years ago has progressed from actuating flaps, landing gear, etc. to a source as vital to the completion of the mission as the propulsive power. The name has changed from *auxiliary power* to *secondary power* to *non-propulsive power* and now is just *power systems* which include energy sources, power extraction and transmission equipment, as well as various drives, generators, regulators, and controls to develop and deliver power to loads.

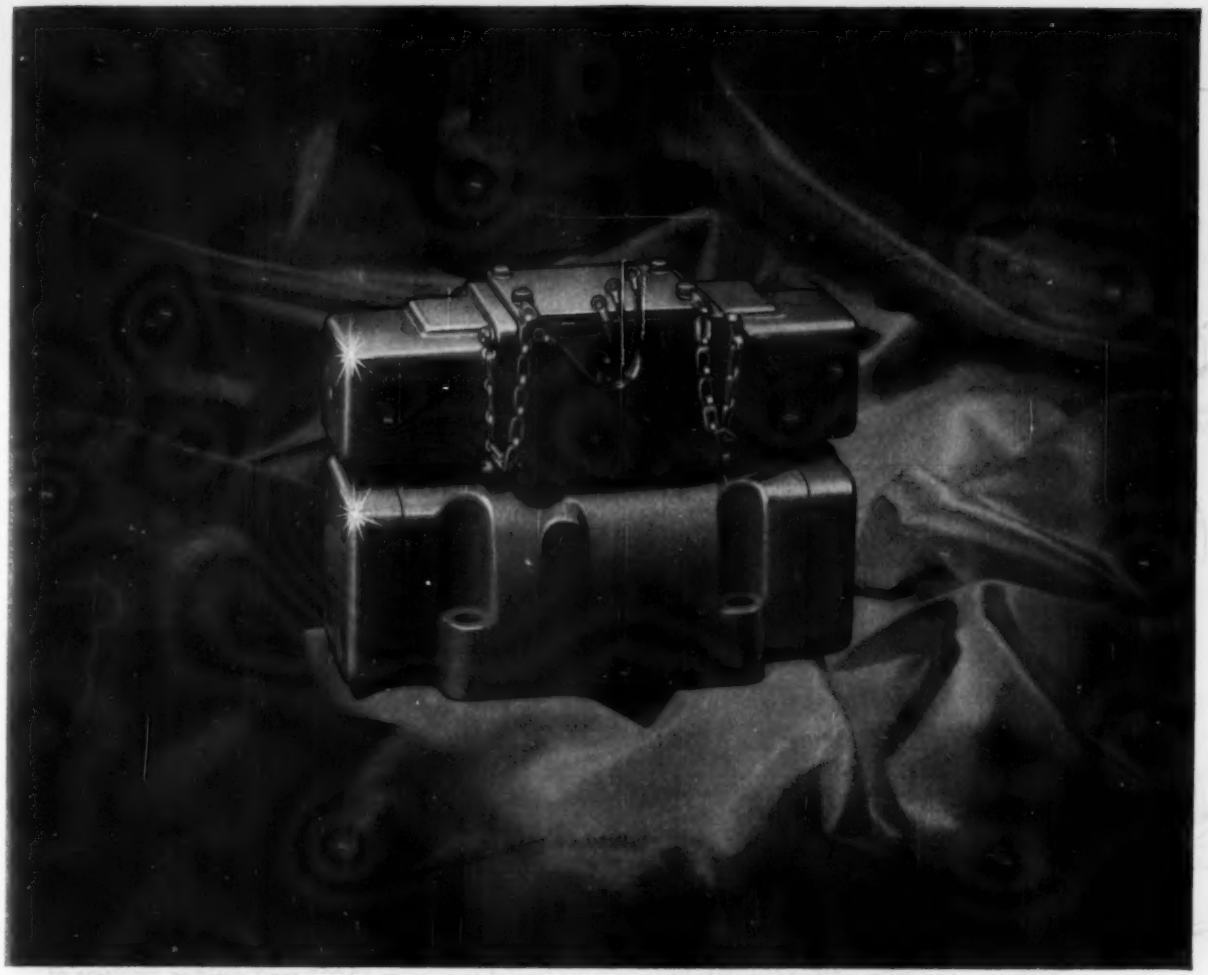
• **Selection factors**—Weight is a basic consideration in selecting a power system. Other important considerations are installation, reliability, logistics, safety, and development time. The significant effect of weight on vehicle performance is characterized best by *growth* or *penalty* factors. These factors show increase in the weight of the overall vehicle required to maintain performance in terms of range, speed, and altitude for weight added by a sub-system or component. Typical penalty factors range from 1.5 to 2 for air-to-air missiles, from 30 to 70 for long range ballistic missiles, and up to 200 for a weapon system including the launching aircraft.

The system offering minimum weight for a given horsepower and duration may be determined from Figure 1. This curve complex was determined by finding the lightest system for each of several power levels from a series of charts of which Figure 2 is typical.

A typical missile requires both electrical and hydraulic power. Several studies have shown that when both power types are installed, the exact load division does not materially change total weight. Therefore a load division of 50% hydraulic, and 50% electrical (25% ac and 25% dc) is assumed in the curves of Figures 1, 2, and 3.

For short duration applications, the specific weight, i.e. pounds per hp, of the equipment becomes more important than the specific propellant consumption

Continued on page 102



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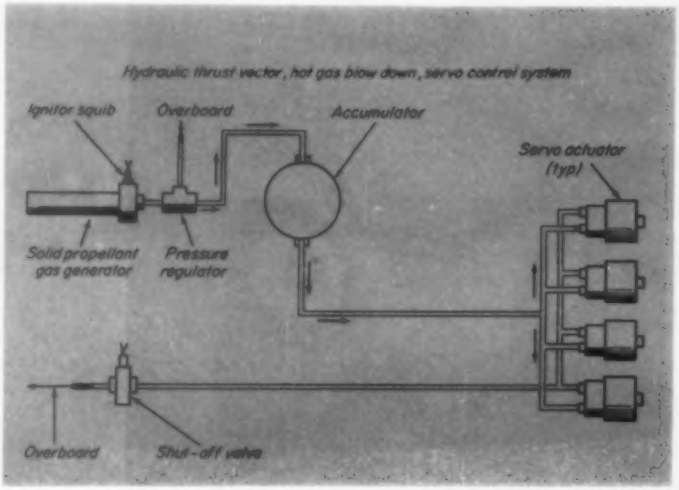
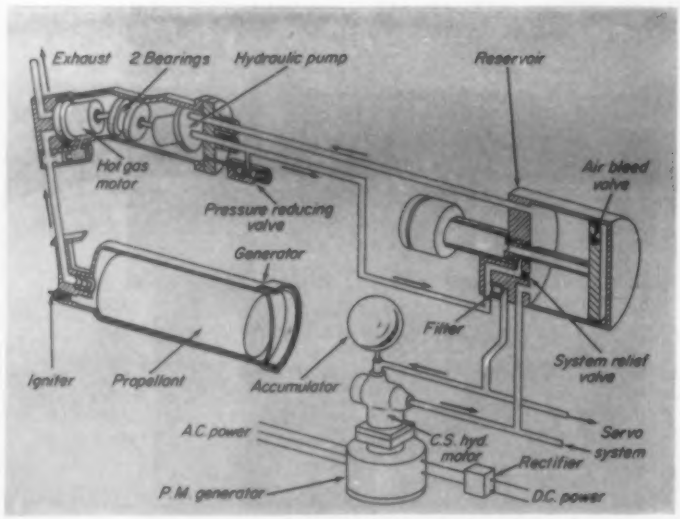
of the fuel. For these applications, the type of power system is often named by the equipment used, such as turbine, hot gas motor, flywheel, d-c motor, and blow-down system. Longer duration systems are usually named for the fuel used, such as hydrogen and oxygen, or hydrazine system. A typical specific weight comparison is shown in Figure 3 for a system duration of 0.01 to 0.10 hours.

□□□



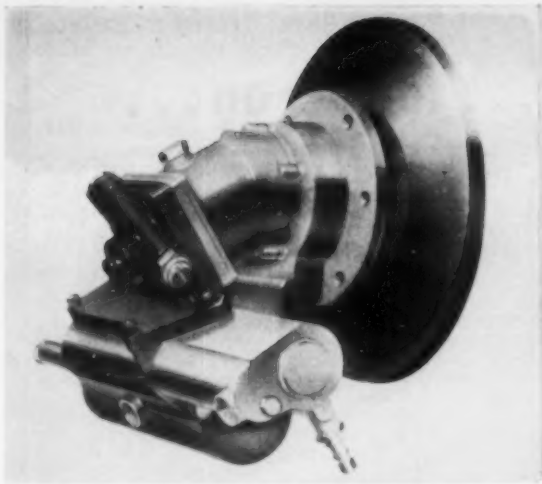
BLOW-DOWN SYSTEM has a hot gas generator ignited from a squib. The hot gas at a constant pressure displaces hydraulic fluid to the servo actuators. Return oil is expelled overboard. Sufficient oil has to be stored to complete the mission. The system is competitive on weight for only relatively short flight durations to 20 seconds. Its big advantages are that it uses no rotating equipment, has a minimum alert time to prepare it for operation, and permits convenient ground checkout.

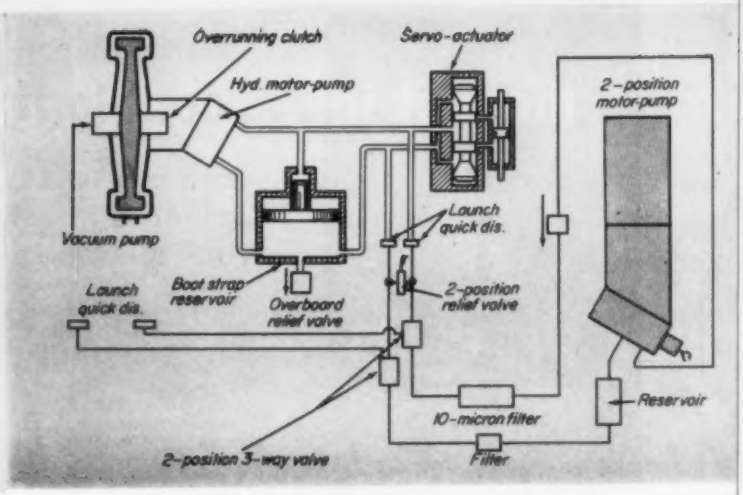


HOT GAS MOTOR SYSTEM has the lightest specific weight of the short duration systems. It uses low speed equipment (maximum 12,000 rpm) avoiding problems of high speed bearings and gearboxes.

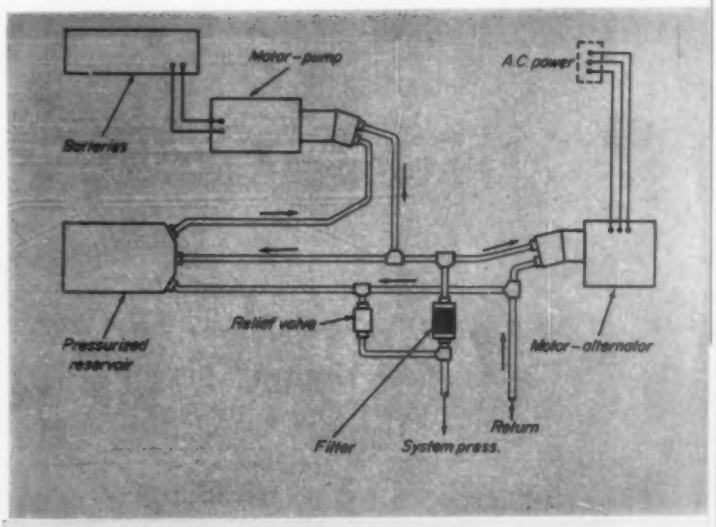
Operation is started by firing a squib actuator which sets off the solid propellant charge. Gas flow from the gas generator passes into the hot gas motor which operates as an external combustion engine. The motor drives the hydraulic pump through a common internal shaft. No major alert time is required because squib firing is instantaneous. Hydraulic flow in excess of system demand goes over a relief valve, eliminating a gas supply regulator. Filtration of the hot gas is not required before it goes to the hot gas motor inlet.

Integrating the hot gas motor and hydraulic pump eliminates hydraulic shaft seals. Fluid from the high pressure supply lines lubricates the hydraulic motor. This system is the most attractive for short duration auxiliary power systems. A package unit including reservoir, relief valve, and filter is shown below.



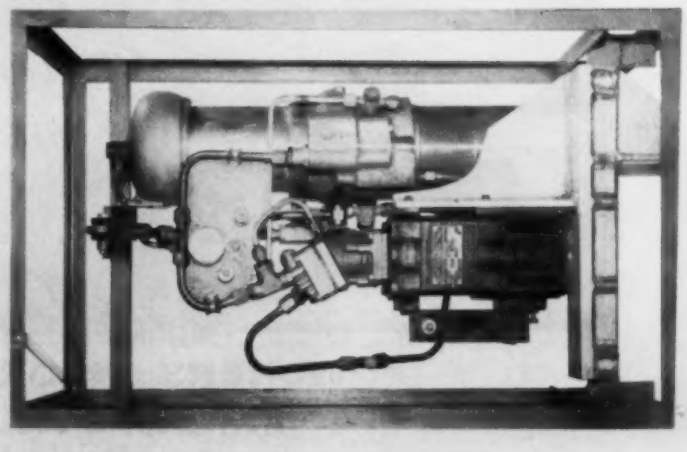


FLYWHEEL SYSTEM looks attractive from the weight and reliability standpoints if there is enough time to run the flywheel up to rated speed. The system can supply a constant speed motor which drives an alternator for electrical power. An integrated design is shown.



BATTERY POWERED SYSTEM use components which have been proved in actual missile flights. The equipment operates at relatively low speed and permits complete ground checkout, except for the silver zinc battery. two to five seconds alert time is usually required for the squib-actuated electrolyte injection into the cells.

This system has a direct source of d-c power often required in missiles. A variable delivery, pressure-compensated hydraulic pump can be used to conserve energy from the battery and reduce weight. Peak hydraulic power may be supplied by a small accumulator to minimize the battery weight. This system permits driving a remote electrical package. Where hardware is required immediately, and some weight penalty can be tolerated, this system appears to be the most attractive. A typical arrangement is shown.



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How far advanced is your project? If it is in the design and development stage, we can *immediately* place a team of hydraulic specialists in your plant to work with your engineers. If it is in the "breadboard" stage, let us give you an alternate proposal. On many applications we have suggested much improved power units at attractive production-line prices.

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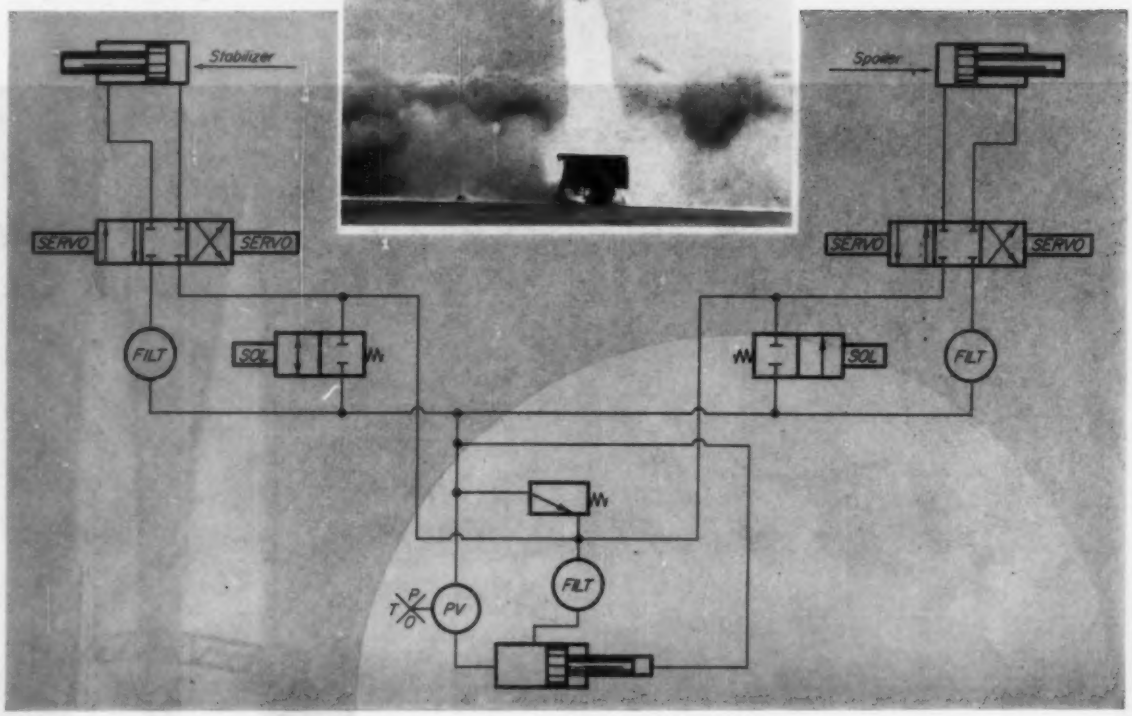
CONTROL SURFACES on the mace are powered by a 1500-psi, hydraulic system.

SERVO VALVES are electrohydraulic and receive feedback from linear potentiometers. Shutoff valves are opened to bleed and flush the hydraulic system before launching.



Fast response with 2-stage servo valves

CONTROLS for a missile traveling near the speed of sound must be fast. The slightest delay in position feedback reaction could send the missile hundreds of miles off course.

For speed and accuracy on the Mace, Martin designers used 2-stage, nozzle-flapper electrohydraulic servo valves for control surface actuators.

The stabilizer servo valve powers the missile's T-shaped tail stabilizer. The actuator is in the vertical fin and linked directly to the control surface. Stabilizer speeds as high as 28 degrees per second are possible with a nominal gain servo valve, and normal aerodynamic hinge movement.

The spoiler servo system drives a cam which operates the finger-type spoilers in the wings. Loads on the spoiler servo are largely due to cam and linkage friction. Spoilers have deflection speeds of 26 ips.

The 4-way servo valves are 2-stage, electrically actuated, proportional type. Flow is in direct relation to d-c input. They are not load-compensated.

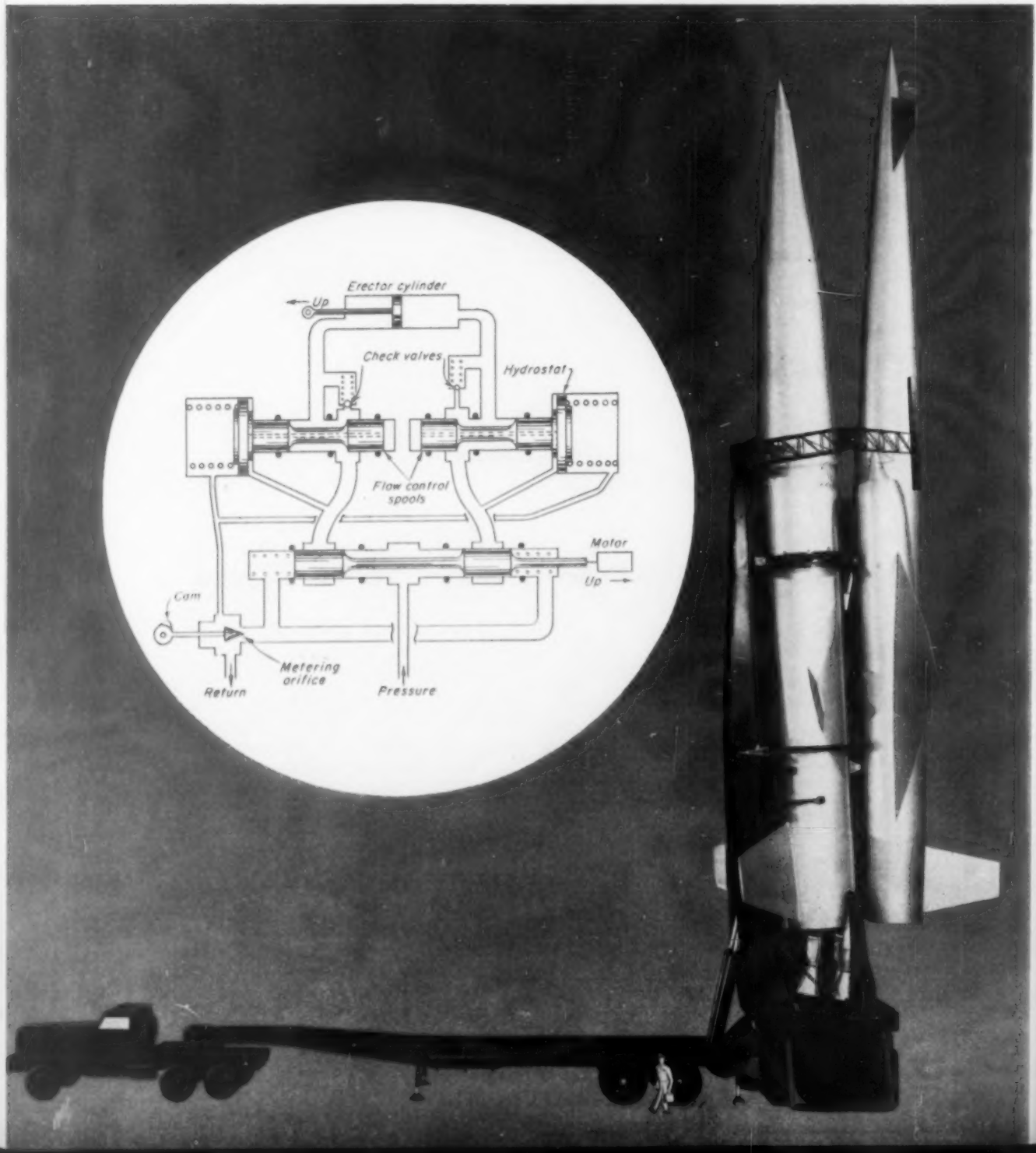
Before launching, the system is bled and cycled with external hydraulic power through ground test disconnect couplings. To flush the system, shutoff valves are opened, and the servo valves and actuators bypassed.

An engine-driven, variable-volume, piston pump furnishes 1500 psi for the circuit. Pressure to the pump suction is maintained by a reservoir pressurized from the high pressure side of the system.

Five-micron filters are located in the high pressure lines to the servo valves. Each servo valve has a built-in filter in the first stage. □□□

Anti-overrun valve controls

One of the components specially designed for missile handling systems is a pressure-compensated, flow control valve. It meters flow from the launcher cylinder during raising and lowering of the missile. Here are the factors that brought its development.



missile erection

• By HARVEY JACOBS, *Project Application Engineer, Marine and Ordnance Dept., Vickers, Inc., Div. of Sperry Rand Corp., El Segundo, California*

ONE of the most critical points in designing missile handling equipment is the sensitivity of the missile. The hydraulic system for a launcher must accelerate the load smoothly and rapidly to the required speed, and then decelerate it to its final position for firing. This smooth motion should be maintained even when there is a changing or over-center load condition. Since launching equipment is usually as light as possible for transportation, it is also quite flexible mechanically. Variations in hydraulic pressure can be amplified through the natural frequency of the structure. This produces shock loads on the missile.

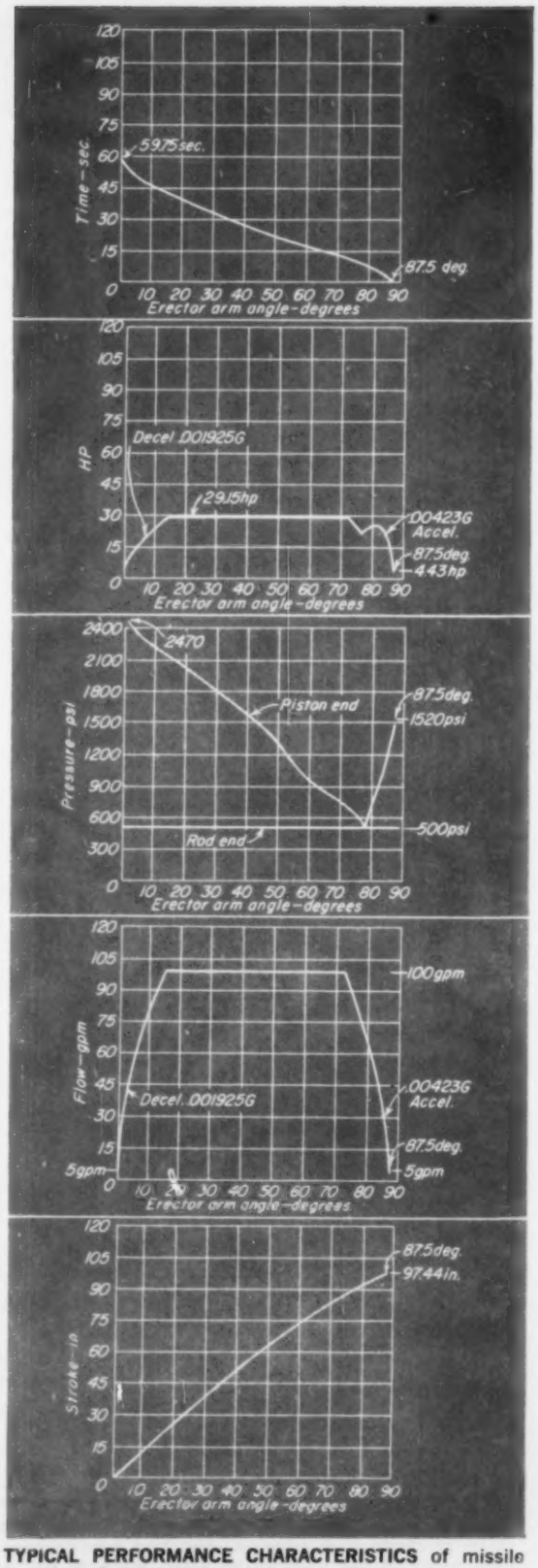
Although the hydraulic system must be completely automatic, it must also be flexible enough for any emergencies. Stops and starts in the middle of a cycle must be at the same rate of acceleration and deceleration. A standard solenoid valve would shift much too fast for this speed control, resulting in high shock loads on the equipment and missile. This factor, and others such as flexibility of the structure and weight limitation has brought many hydraulic components designed for missile ground handling equipment.

• **Early systems**—In the early launcher programs, the system most often used to control the erector cylinder had a standard, 4-way valve for directional control with a counterbalance valve for control of the overhauling (negative) load. Acceleration and deceleration were controlled by cushions built into the cylinder. This was the best system that could be designed with the available components, but it soon became apparent that it was inadequate.

The standard 4-way valve was satisfactory when the cylinder was in its cushioned position, but it shifted much too fast when the load was moving. A valve shift resulted in severe slamming with high pressure surges and shock loads on the system erector and missile.

Counterbalance valves were an even greater weakness. As the load passed center and began to fall, cylinder head-end pressure dropped, and the counterbalance valve closed, reducing flow from the cylinder to tank. When back pressure built up, pump pressure also built up, so the counterbalance valve opened. This resulted in a continuous hunting.

Cylinder cushions to control acceleration and de-



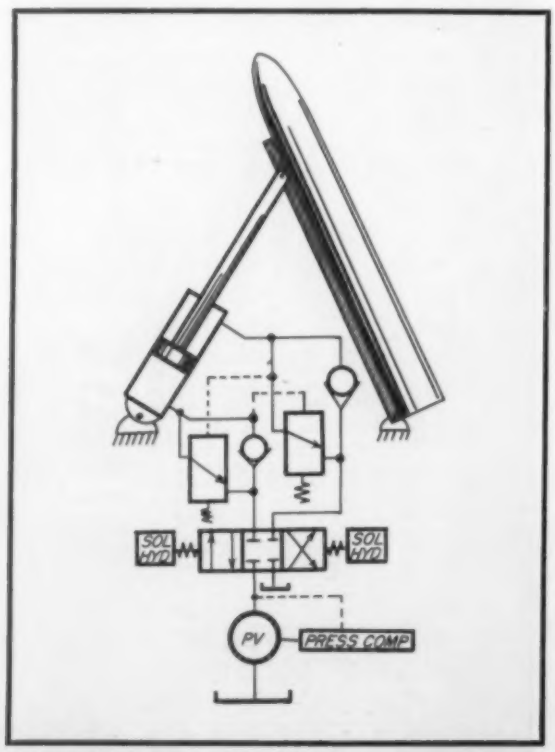
TYPICAL PERFORMANCE CHARACTERISTICS of missile launcher. Curves show variation in speed, pressure, and power as missile is raised for launching.

celeration were also unsatisfactory because of their limited control and the change in speed with temperature changes.

• **Anti-overrun valve design**—The anti-overrun valve, shown diagrammatically, is based on experience with bomb bay doors, dive brakes, and other aircraft applications which operate with extreme load changes. The valve is a meter-out type which has a fixed orifice for control of flow. Hydrostats, or pistons which adjust variable orifices upstream from the fixed orifice, pressure compensate the fixed orifice so that it has a fixed pressure differential. Two hydrostats are used in this valve. Each acts in one direction of cylinder movement while the other is bypassed by a check valve. The metering orifices of the hydrostats are sized according to the head-end and rod-end areas of the cylinder.

A motor-actuated, 4-way directional control valve is built into the valve assembly for emergency stops. It takes control away from the programmed orifice and starts or stops the launcher at a pre-selected rate. With mechanical control of the fixed orifice, the entire operation of the erector can be programmed.

The complete cylinder control is in one package with no external lines, except to pump and tank. The valve is mounted directly on the cylinder to give the fail-safe feature.



EARLY MISSILE LAUNCHER SYSTEM had counterbalance valves to create back pressure when load became negative. Resulting rise and fall of pump pressure set up pressure surges.

5 Rules for Designed Missile Handling Equipment

1. **RELIABILITY**—The system should have the fewest components, lines, and connections possible. Components should have simple design. Movements should be kept to a minimum. Remember that the missile is no more reliable than the support equipment.
2. **PREDICTABILITY**—Missile firings are all completely programmed and require a high degree of predictability. The time from the detection of a target until firing must be measured in seconds. The hydraulic system for raising the missile to its firing position must always operate exactly the same regardless of external conditions such as winds, temperature and changing loads.
3. **SERVICING**—The "black box" concept is effective in designing for simplified servicing. All components are factory adjusted and require little or no adjustment on installation. This provides built-in stability rather than adjusted stability. It is important because of the lack of highly trained personnel experienced in hydraulic equipment at most missile installations.
4. **SAFETY**—The load being handled is dangerous, so one of the first considerations must be for the safety of personnel and equipment. All equipment must be designed fail-safe. No equipment failure can affect the general safety of the area.
5. **COST**—The designer must remember that the equipment often has to be produced in large quantities at a price the nation can afford to pay.

• **Design example**—The launcher for the Navahoe missile shown in the illustration had to be light enough to fit inside a cargo airplane. The erector also serves as a transportation dolley to carry the missile from the storage area to the launching pad. There the erector brings the missile to firing position. In placing the missile on the pad which is behind the erector, the missile center of gravity passes over the erector pivot point. This reverses the load on the erection cylinder. Since the navigational system is put in operation before the missile leaves the storage area, any shock could cause error, and extreme care must be taken to protect the missile.

The system is powered by a variable displacement pump with the anti-overrun valve controlling the cylinders. A cam arm links the valve to the erector structure to give mechanical control of the measuring orifice regulating speed during erection. The load is very large, and the space is limited, so two erection cylinders are used. The cylinders are manifolded together and mechanically synchronized. Though the Navahoe program has been cancelled, the development work is applicable to other missiles. □□□

Circle 88 ➡

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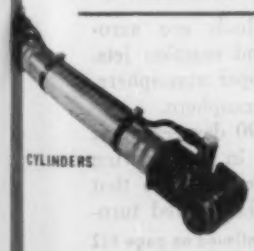
Designed for automatic, dependable regulation of any hydraulic systems, Kemp Regulators have been especially developed as precision components for all aircraft, missile, launching and ground support pressure regulating systems. All Kemp Regulators are manufactured of highest grade materials and faithfully conform to strict military and commercial requirements.

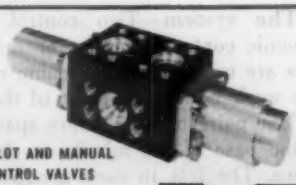
Kemp Regulators are precision engineered to exacting specifications and can be provided to meet operating pressures varying from 0 to 5000 PSI. Rugged construction permits enduring operation under extreme temperature conditions ranging from —65° to 500°F.

SOLENOID CONTROL VALVES

PRESSURE SWITCHES



CYLINDERS



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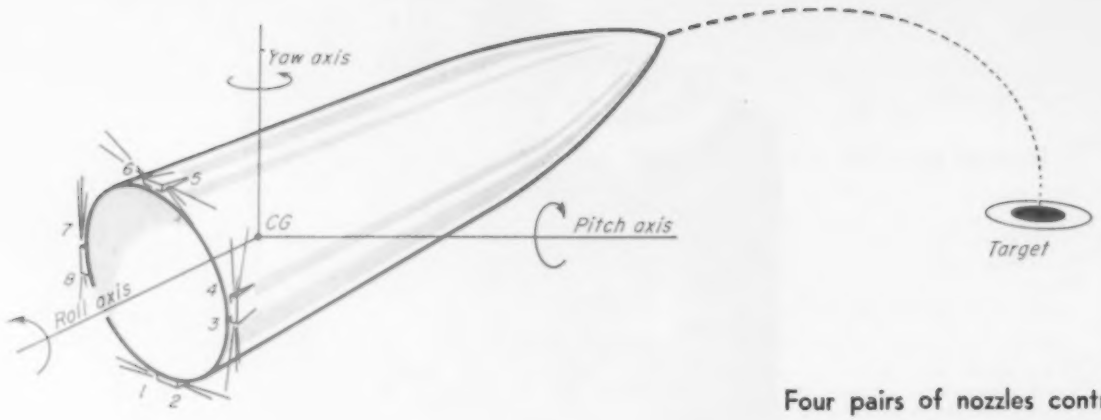
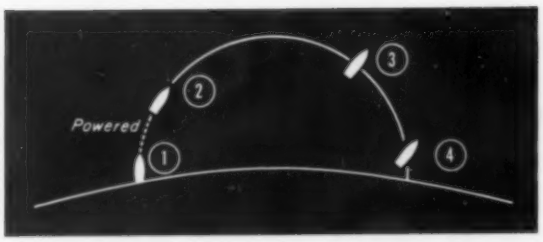
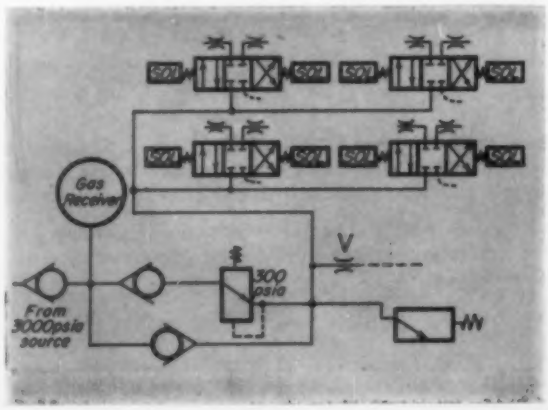


Four pairs of nozzles control missile attitude. A 300-psi air circuit directs flow to the jets.

Selecting valves for missile pneumatics



WITHOUT SPATIAL CONTROL, missile attitude remains constant from the end of powered flight (position 2) where it is inclined at an angle of approximately 45 degrees. On re-entry into the atmosphere (position 4) the missile would approach tail first.



PNEUMATIC SYSTEM regulates 3000-psia gas to 300-psi which is applied to four solenoid valves. Each valve controls flow to two reaction jets. Needle valve permits manual bleeding to set regulator.

AFTER the propulsion phase of missile flight, while the missile is in a ballistic path, some method is required to make small corrections in its attitude so it will re-enter the atmosphere, nose first. Without such corrective measures, the missile attitude will be as shown in the drawing (left) so that it will probably re-enter tail first. The structure will be subjected to very large deceleration forces which will break up the missile.

This can be avoided by applying a force on the missile so that its axis is always parallel to its flight path. Upon re-entry drag forces are then a minimum, because of the small frontal area. Also the missile has maximum structural rigidity in this attitude.

During the missile's initial rise out of the atmosphere, the flight path deviates from that required because of unusual winds, the jet stream, atmospheric conditions, and any irregularities in launching. During powered flight, the missile is under its main control system, but a small error at the termination of powered flight can cause a large final error in impact point. Therefore the system to provide proper re-entry attitude may also correct any deviations in the flight path.

• **The system**—Two control methods are aerodynamic control surfaces, or fins, and reaction jets. Fins are useless in the vacuum of upper atmosphere. Jets work both in and out of the atmosphere.

Four pairs of nozzles are spaced 90 degrees apart at the base of the missile as shown in the drawing above. The jets in each group are opposed so that by operating them in combination the desired turn-

Continued on page 112

Circle 104 ➡

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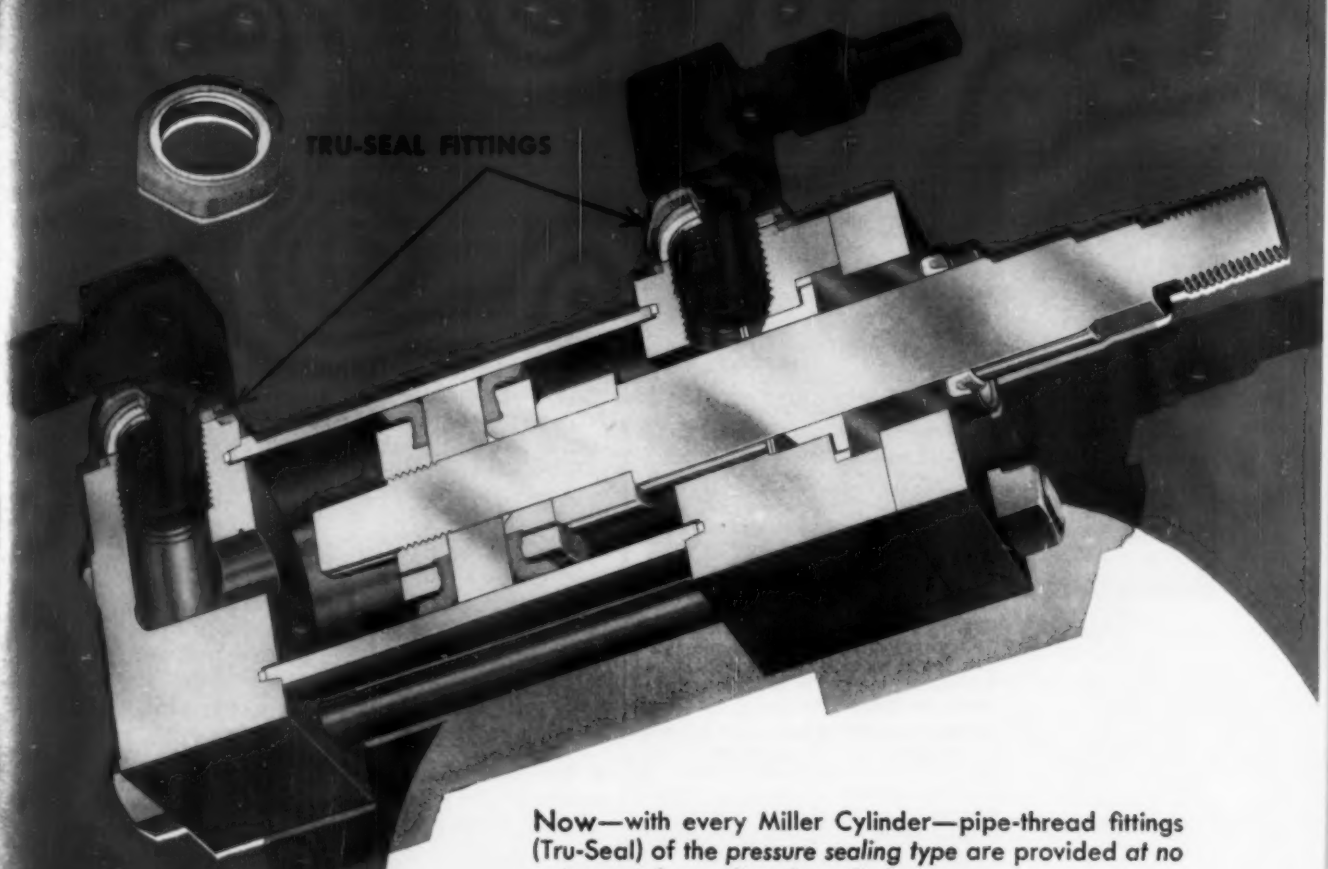
(J.I.C. Standard No. 2.2)



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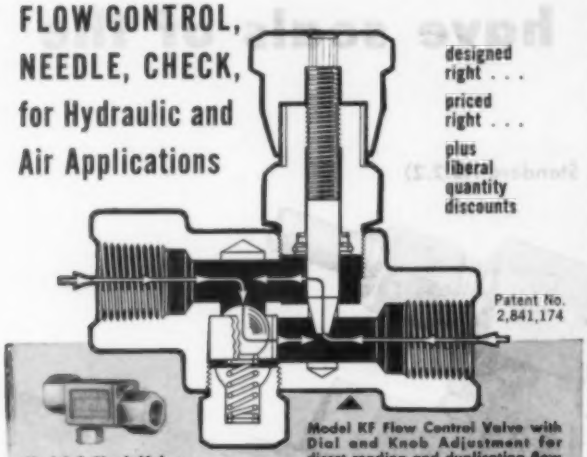

Patent No. 2,841,174

Model KF Flow Control Valve with Dial and Knob Adjustment for direct reading and duplicating flow settings. Now available in Aluminum for 3000 psi.

Model C Check Valve for In-Line Mounting.

Model F Standard Flow Control Valve or Model N Needle Valve.

Model KF Knob and Dial Flow Control Valve or Model KN Needle Valve.

Model PF Knob and Dial Flow Control Valve or Model PN Needle Valve for panel mounting.

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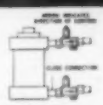

Figure 1

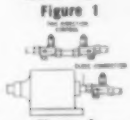

Figure 2

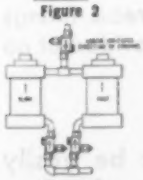

Figure 3

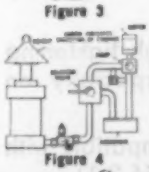

Figure 4

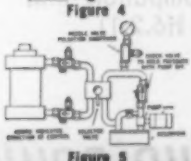

Figure 5

MINIMUM PRESSURE DROP AND POWER LOSS . . . Oversize ports and passages give maximum flow at minimum pressure drop, insure accuracy and response in hydraulic or large volume air cylinder control.

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Fig. 1—SPEED CONTROL for Double Acting Cylinders

Fig. 2—SPEED CONTROL for Single Acting Cylinders

Fig. 3—SPEED CONTROL . . . Cylinders in parallel

Fig. 4—RETURN SPEED CONTROL, typical hydraulic hoist

Fig. 5—Various uses of AUTO-PONENT Valves in hydraulic power systems

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ing moment can be obtained. They are controlled by solenoid valves actuated by the guidance system.

Jets 5 and 2 or 6 and 1 rotate the missile around the yaw (vertical) axis. Jets 3 and 8 or 4 and 7 rotate it about the pitch (longitudinal) axis. Rotation about the roll axis is done by all odd numbered jets or all even numbered jets. Control about these three axes is required for accuracy.

The pneumatic system, shown in the diagram has four solenoid-operated, 4-way valves controlling flow to eight converging-diverging nozzles. Air or nitrogen at 300 psia is supplied from a pressure regulator. High pressure gas at 3000 psia is stored in a sphere. A needle valve is downstream of the regulator to bleed gas slightly when the regulator is first set. A relief valve protects personnel against over-pressure in the system. The bypass line around the regulator depressurizes the line downstream from the regulator when the sphere is exhausted after a missile checkout.

• **Components**—Even though this system is simple, the design requirements were severe. The useful life of the missile is measured in minutes, but the components must operate for many hours. If the missile is checked out only once a week for three to five years, each component must stand 150 to 250 simulated flights, and it must always work perfectly.

If there are ten components in a system, each with 99% reliability, the system is 90% reliable. If there are five systems in the missile with 90% reliability, the missile's reliability is 59%. Obviously, each component must be as nearly perfect as possible.

Reliability is the missile designer's religion, but his high priests are weight and space. It is possible to overdesign for reliability. System duplication and parallel circuits take up space, increase weight, and lower performance. Therefore, each component should be as foolproof as possible.

• **Pressure regulator**—Thrust from the nozzles depends upon the regulated pressure which must be carefully controlled. The pressure regulator must hold preset pressure closely while allowing a wide range of flow. The regulator must perform as well with one nozzle as with four. The regulator must also withstand vibration, high "g" loadings, and an extreme temperature and atmospheric pressure range. For best performance, the system should have a two-stage regulator, or better still, a separate regulator for each set of nozzles. However, such a system is bulky, heavy, and less reliable because of the number of components. It is preferable to use a single regulator.

Thrust required from each jet is approximately 5 to 10 lbs. The flow rate through the regulator is .095 lbs/sec to .191 lbs/sec of nitrogen per actuated nozzle for this thrust.

In developing this system, one regulator operated all right at room temperature, but at —65F some dynamic O-ring seals with a slight squeeze had shrunk so much they leaked, and the regulator failed. Moisture was another problem. The temperature drop of decompressing gas, and the high altitudes can cause

Concluded on page 115

Circle **121** ➡

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From HANNIFIN... unit construction to give you air valves that do more jobs

Hannifin ⅜" four-way valve with "universal" base and new Speed Control section. Single-solenoid actuated, 10 other actuators available.

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When it comes to actuation, Hannifin offers an even wider selection: hand, foot, cam, pressure, single or double solenoid.

When necessary, you can remove this entire valve from its base without disconnecting air lines. Or, the exclusive "spool-poppet" can be replaced without even breaking electrical connections.

The "CC" series, like all Hannifin valves, is designed with "full flow" internal passages as large or larger than its rated pipe size.

You will find these and most other Hannifin valves described in Hannifin's new "Valve Finder." Get your copy from your Hannifin man, listed in the A-Z volume of Thomas' Register, or write:

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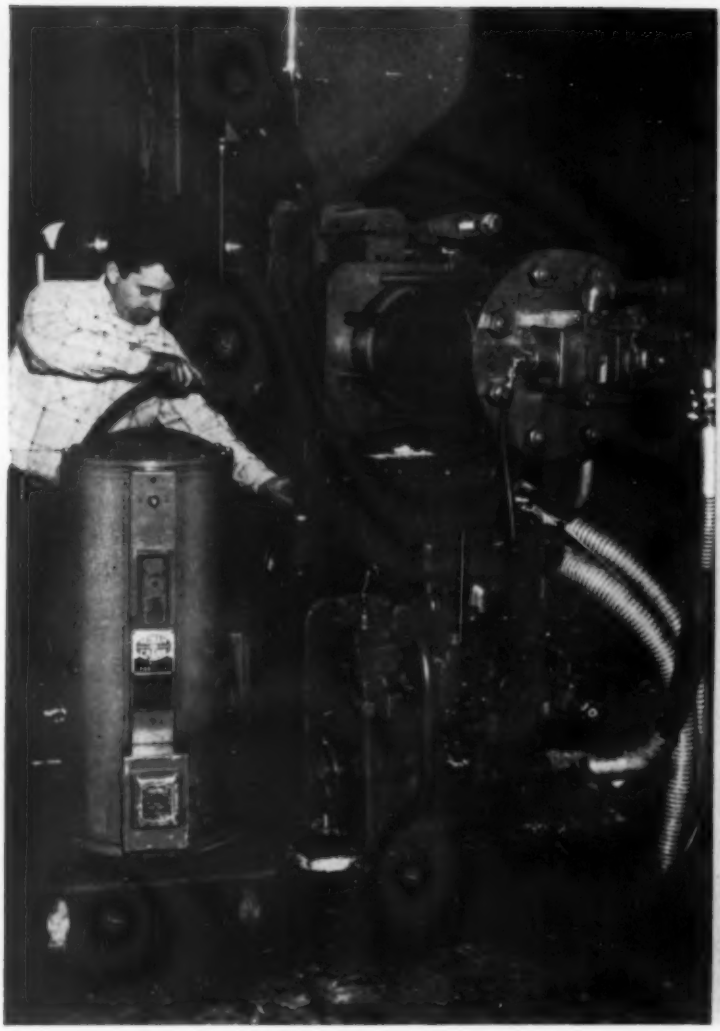
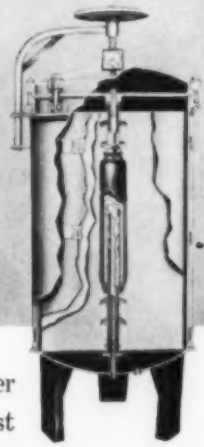


CFC HONAN-CRANE HYDRAULIC FILTER lowers operating costs on Injection Molding Presses

At Leaf Plastics, Inc., Yonkers, N. Y. this portable CFC Honan-Crane Bulk Type Filter purifies the hydraulic oil on nine injection molding presses.



Leaf Plastics, Inc., prolongs the life of their injection molding presses by reducing wear on precision fitted moving parts through the use of CFC Honan-Crane Hydraulic Filters. They enjoy definite dollar savings in reduced down time, maintenance and increased productive man-hours.

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SELECTING VALVES FOR MISSILE PNEUMATICS

Concluded from page 112

icing and clogging of passages. Future designs may require heating the gas to the regulator with auxiliary sources such as the rocket motor. But a truly satisfactory regulator must still be developed to meet these conditions:

1. Operation from −65 F to +165 F
2. Operation in an atmospheric pressure from 14.7 psia to 0 psia.
3. Static loads of 20 g's
4. Vibrational loads of 25 g's
5. Outlet pressure of 300 ±10 psia with an inlet pressure from 3000 to 400 psia.
6. Maximum size 3 x 4 x 4 inches
7. Flow from 0 to 0.8 lbs/sec of nitrogen with no appreciable change in outlet pressure.
8. Completely reliable and foolproof.

• **Solenoid valves**—Valves have been developed further than regulators and the prime considerations are size, weight, and reliability. There is a selection in the present market, and the designer has his choice depending upon preference, experience, and application. For other than large valves (¾ in. or more) a 28-volt, d-c solenoid valve is the popular choice.

Selection of components for a spatial control system is typical of the present missile system design practice. Each system must be as reliable and simple as possible, because of the complexity of the complete missile. Regulators, valves, and other components wherever possible are "off the shelf" items because their performance is well known. □□□

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Using Hydraulic Oil of 170 SSU Viscosity at 100° F Temperature

CYLINDER SELECTION TABLE

Piston Dia. Inch	Cylinder Force Lbs. 50 PSI	100 PSI	150 PSI	200 PSI	Cylinder Speed Inch/Min.
1	39	78	117	157	294
1¼	62	123	184	245	188
1½	88	177	265	353	131
2	157	314	471	628	73

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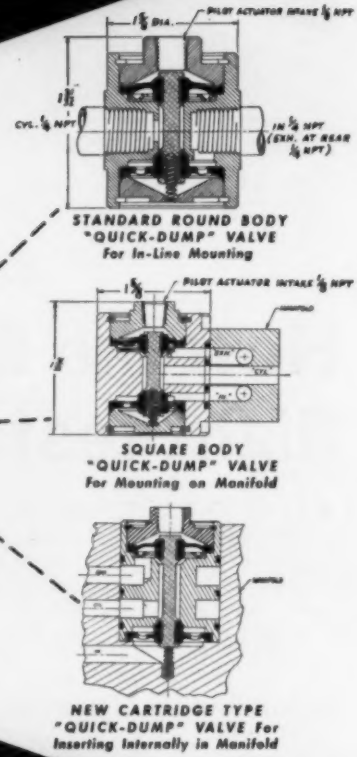
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There are round, square, cartridge styles; 2-way, 3-way, 4-way; ⅛", ¼", ½" sizes; manual, electric, or pilot-operated. All valve air, oil, water, other liquids, gases to 125 psi. Also vacuum.

Utilizing the flexibility of "Quick-Dump" Valves, Humphrey engineers are producing a continuous flow of new pneumatic controls, both for plant processing and OEM applications.

Your control problem may also lend itself to ready solution through the use of "Quick-Dumps." Consult the Humphrey engineering department.

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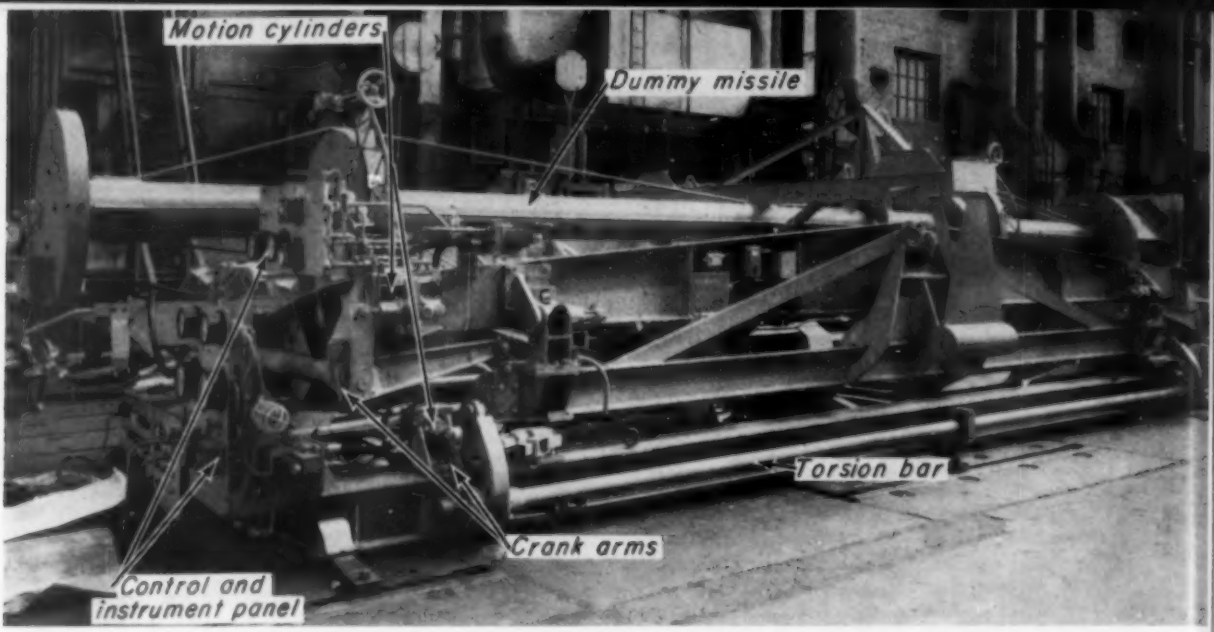


BOMARC EXERCISER with dummy missile installed for test. Cylinders twist torsion bars to simulate flight loads on the missile in each of three axial directions.

How the Bomarc gets flight tested on the ground

• By OTTO GRUPP, *Field Engineer*
ITT Federal Division of International Telephone & Telegraph Corp., Fort Wayne, Indiana

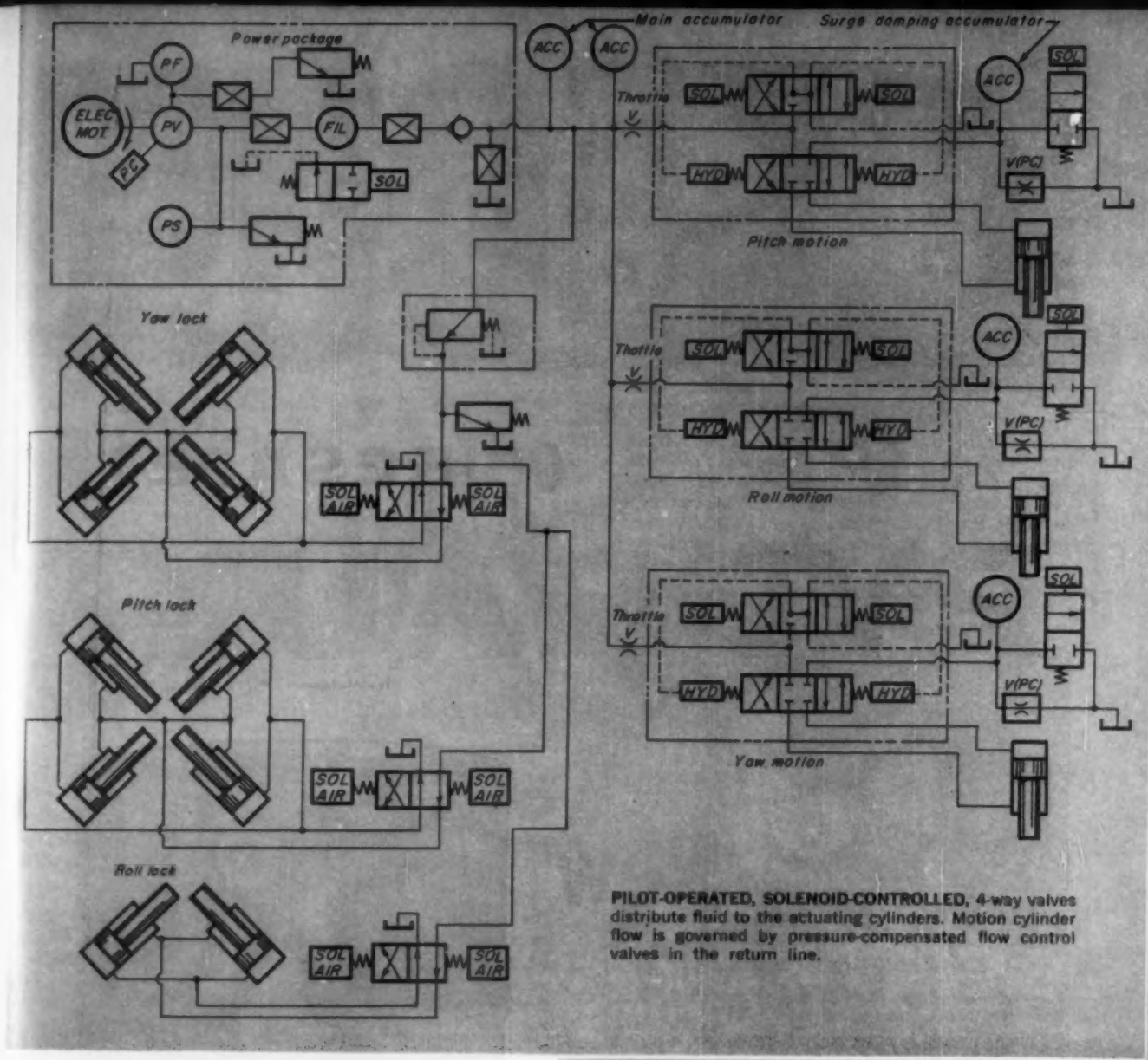
Rather than use a complex, modulating hydraulic control system to simulate loading, this Bomarc exerciser has an on-off hydraulic system acting through torsion bars.

MISSILE maneuvers can be reduced to simple harmonic motions in their pitch, roll and yaw axes. By actuating cylinders in each of these axes, all directional attitudes can be simulated. The Bomarc is rocked back and forth in a uniform cycle through a small arc in each plane. Peak accelerations occur at the end (or turning) points, and peak velocities at the midpoints of the cycle. This sine wave configuration is derived from a constant flow hydraulic square wave by means of cylinder force twisting a torsion bar linkage grounded to a structural element of the exerciser. This mechanical conversion method eliminates the need for an elaborate hydraulic servo system.

• **Supercharged Power Unit**—The hydraulic system is built with standard industrial components. In the power package, a variable displacement pressure compensated pump is supercharged by a small, constant delivery pump. This booster pump feeds 60 psi oil to the main pump inlet to prevent cavitation. During startup a time-delayed solenoid valve is connected to the vent chamber of the main relief valve. Solenoid valve closing is delayed 2 to 3 seconds by a thermal timer after the pump motor is started, so that the pump is started under no load. A micronic/magnetic filter at the outlet side of the pump removes contamination.

• **Meter Out Flow Control**—Fluid from the power package is distributed through two branch lines to control panels on the main base and on the pitch frame. Each branch line has an 1100 psi bladder accumulator to supply peak impulses demanded by the system. Roll, pitch, and yaw motions are each controlled by a pilot-operated, 4-way solenoid valve.

Each of these valves has a needle valve to throttle flow on the inlet line. There is a pressure compensated meter-out circuit for each valve. Each flow control

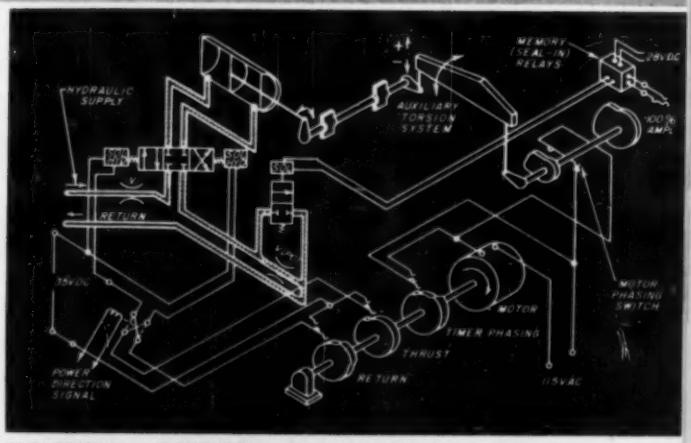


PILOT-OPERATED, SOLENOID-CONTROLLED, 4-way valves distribute fluid to the actuating cylinders. Motion cylinder flow is governed by pressure-compensated flow control valves in the return line.

can be by-passed by the 2-way solenoid valve to maintain constant amplitude.

Cylinder motion is linked to a torsion bar system to build up roll, pitch, or yaw rotation gradually to full amplitude.

• **Locking System**—Supply fluid for the locking circuits passes through a pressure-limiting valve and is reduced to 600 psi. Air piloted, solenoid 4-way valves activate lock systems in any plane of motion. The pilot system of the 4-way valves and the low pressure accumulators use 90-psi shop air. Locking cylinders are actuated simultaneously in each axis; four each in the pitch and yaw axes, and two in the roll axis. □□□



ELECTRICAL, MECHANICAL AND HYDRAULIC components team to regulate and actuate an axial load. Cam times solenoid signals which govern flow to the cylinder. Stroke is converted to torsional force acting on the missile.

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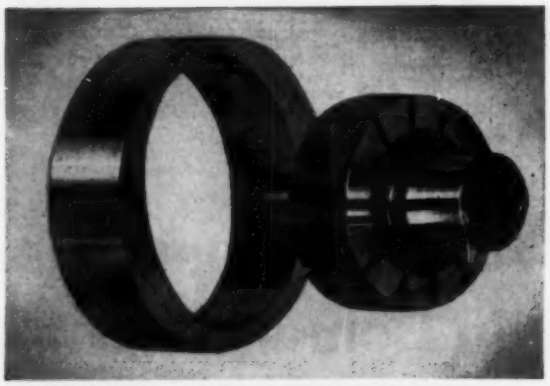
*AMS-3150B high-pressure ignition test



CUTS WEAR AND MAINTENANCE

Pydraul A-200 lubricates like finest petroleum oils, resists "abuse" better than other fire-resistant fluids, minimizes down time. Example: Vickers pump ring (above) shows only 0.031 g. wear after severe 1000-hour test.

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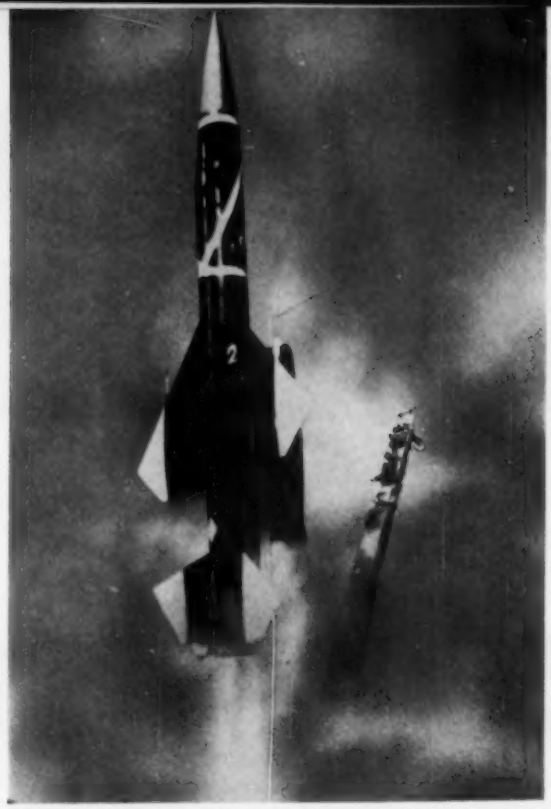
Pydraul A-200 won't rust metals, eliminates electrolytic corrosion. Perfect score on rust test (above) proves Pydraul A-200 *protects* metal surfaces, even if water gets in the system!

To meet system demands, Boeing had to devise some new component ideas in—

- *Actuators*
- *Filters*
- *Accumulators*
- *Reservoir*
- *Power Transmission*



BOMARC LIFT-OFF. Streamlined housing on the top side of the missile contains hydraulic lines and an accumulator.

Special component designs in Bomarc flight system

• By DAN J. TINIUS, *New York Air Brake Company**

HYDRAULICS aboard the Bomarc missile powers the flight control system, including guidance and the aerodynamic control surfaces. Electrical signals from guidance commands control electrohydraulic servo valves and they regulate control surface motion. A motor-driven, variable displacement pump delivers 8 gpm at 3000 psi. MIL-H-5606A fluid, with contamination controlled to 0.3 milligram per 100 milliliters is used in the system.

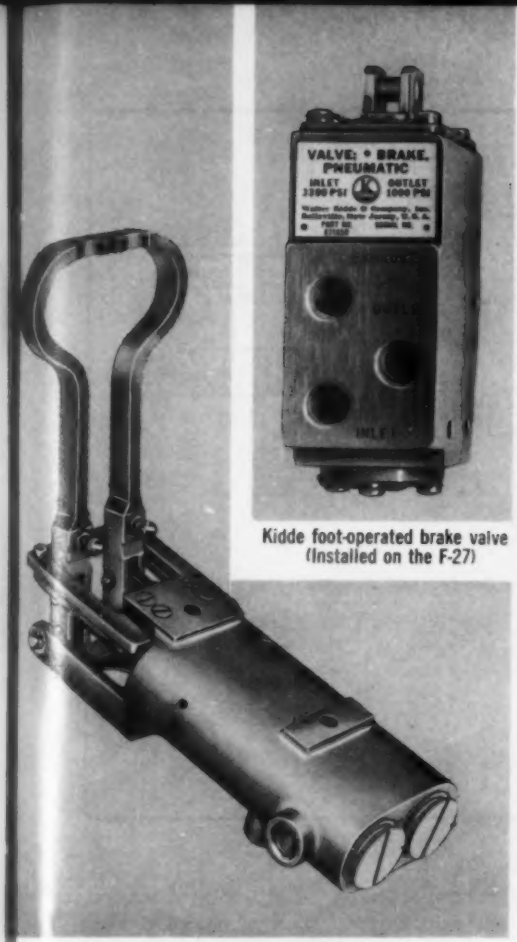
Main components of the system are installed as a package near the aft end of the missile. Stainless steel tubing conveys power to the elevator linear actuator, the gimballed rocket motor linear actuators, and the rudder hydraulic motor. Fluid lines are brought forward under an external fairing along the top side of the missile to the aileron and roll stabilized bulkhead hydraulic motor drives. An accumulator is also mounted near the forward end of the fairing.

• **Filtration**—Output flow of the pump goes through a magnetic-micronic filter. The magnetic portion, a Boeing design, was developed to combat magnetic contamination of servo valves. Fluid flows through iron filings packed between poles of a magnet. The magnetic flux in the small gaps around the iron particles draws magnetic particles out of the fluid.

Filter efficiency increases as it loads up, until a very heavy deposit causes the fluid to by-pass the filter. As the amount of trapped contaminant increases, the pressure drops to a minimum and remains at that level. To protect the system from non-magnetic solids, a micronic filter element is located within the magnetic element and downstream of it. A differential pressure relief valve opens, and by-passes the fluid around the micronic filter when the pressure drop across this element exceeds 100 psi. The collapsing pressure of the micronic element is 350 psi.

• **Accumulators**—Two 150 cu. in. cylindrical accumulators used are chromium plated in the bore to prevent magnetic contamination and provide suitable wear properties. Electroless nickel plating is now being

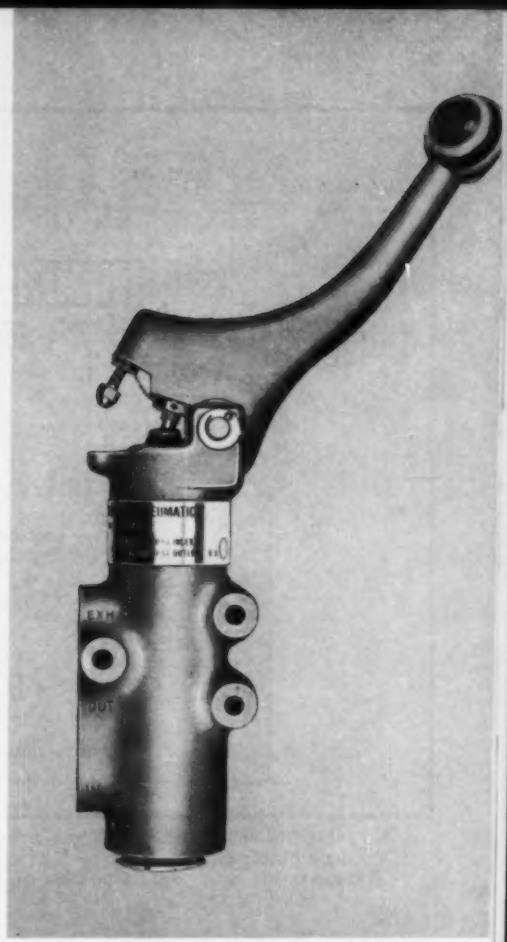
Circle 90 ➡



Kidde lever dual brake valve (Installed on F-27, de Havilland Caribou, and Howard Ventura)

Kidde foot-operated brake valve (Installed on the F-27)

Kidde handwheel-operated brake valve (Installed on Convair 880 and 600)



Kidde lever-type brake valve (Installed on the F8U, F8U-3, and Aero Commander)

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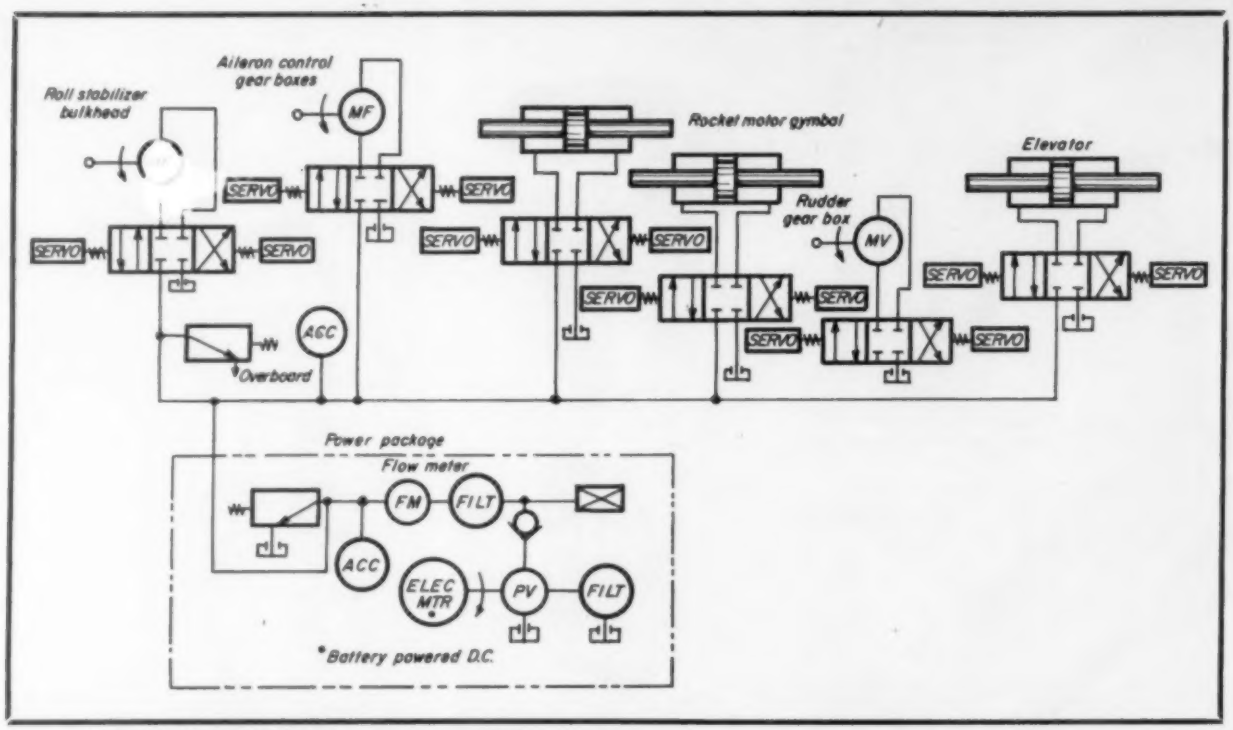
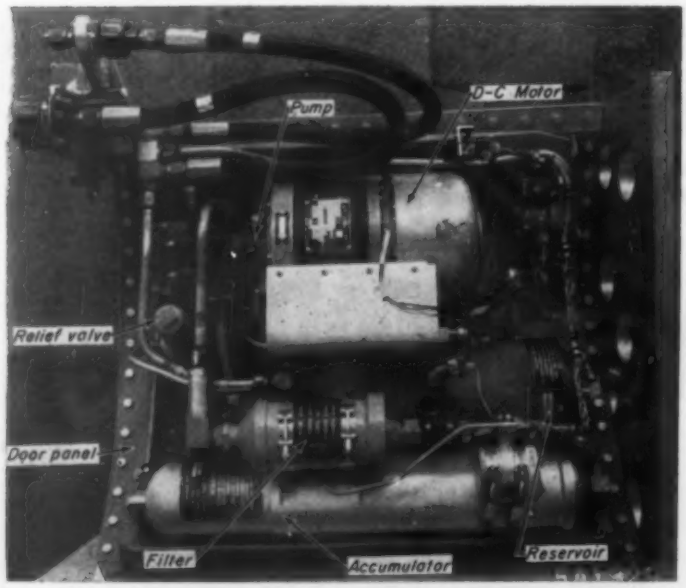


AILERON AND RUDDER motors are geared down to reduce flutter effect caused by fluid compressibility. Basic components are grouped in the power package.



POWER PACKAGE mounted on a miss le panel. The variable displacement pump with its d-c motor, the dual filter, and accumulator are in the foreground. Reservoir is in the background.

evaluated for this purpose. Tests with crack-free chromium plating show that there is no wear when cycling the accumulator piston between 2000 and 3000 psi for 500,000 cycles. In earlier accumulators, leakage problems arose from air precharge expelling fluid from the system. In redesign, a venting system was incorporated to prevent air from leaking to the fluid side of the piston. Venting both sides of the piston to the atmosphere cut maximum air leakage to a rate of 2 cc/hr with a precharge of 2000 psi corrected to 40 F.

• **Reservoir**—The piston-type reservoir proved its reliability in vibration, high temperature, and cycling tests. A rod sight gage is for ground servicing, and an overflow port prevents pressure build-up from thermal expansion of the oil. The port is uncovered when the piston reaches the end of its travel. The return line pressure to the pump is kept at 65 psig with 3000-psi pump pressure.

• **Power package**—The hydraulic power package, consisting of the main components, is mounted on a door panel to withstand vibration and transmit structural loads across the door opening. The panel is not hinged, but it may be unbolted and supported on brackets for ground test. When the missile is in the launcher, hydraulic components are serviced through a smaller access port.

• **Actuators**—Linear actuators position the elevator and the gimballed rocket motor. Servo valves are close coupled to the cylinders to minimize oil-column length for maximum flutter stiffness of the elevator. The

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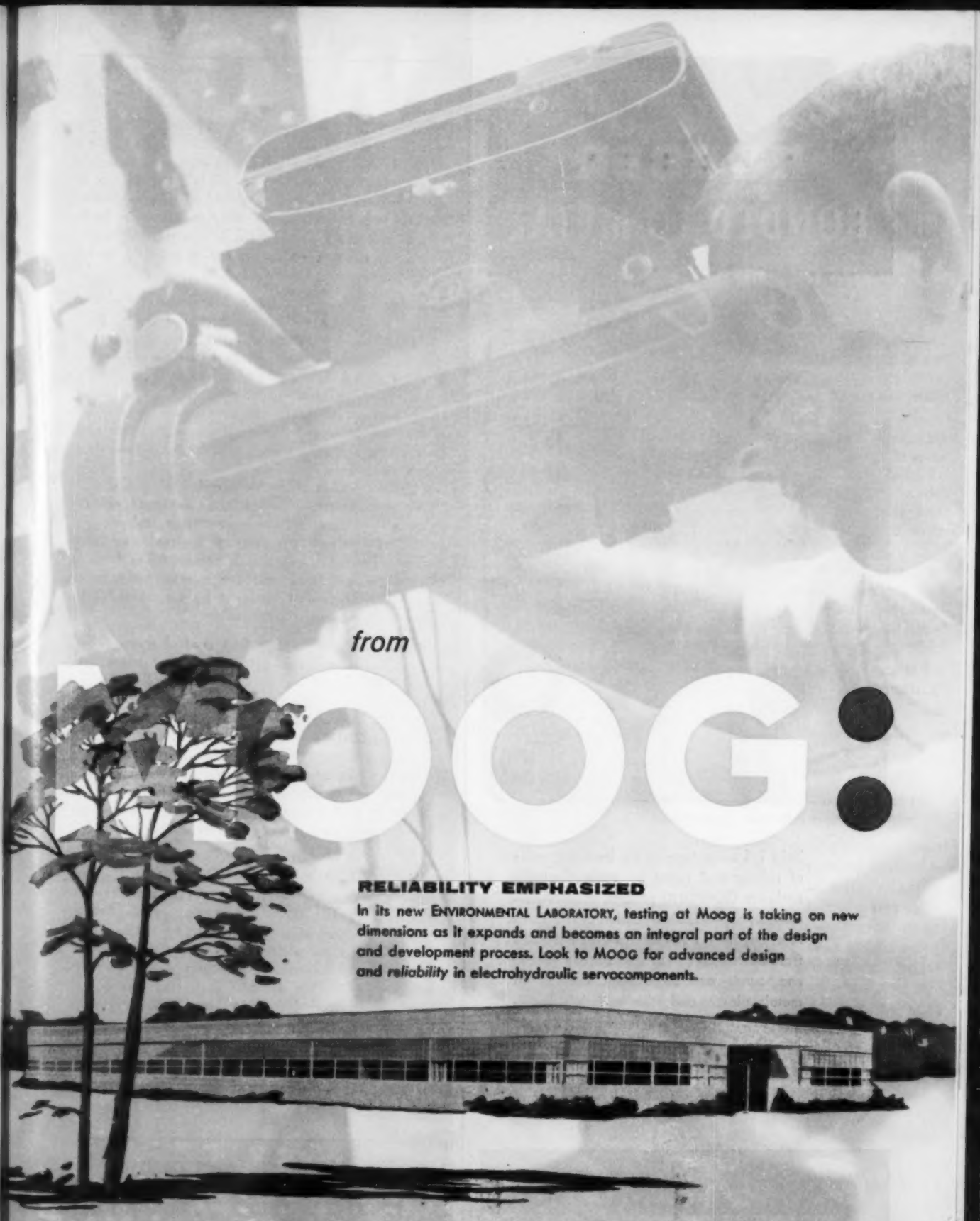
Circle 108 ➡



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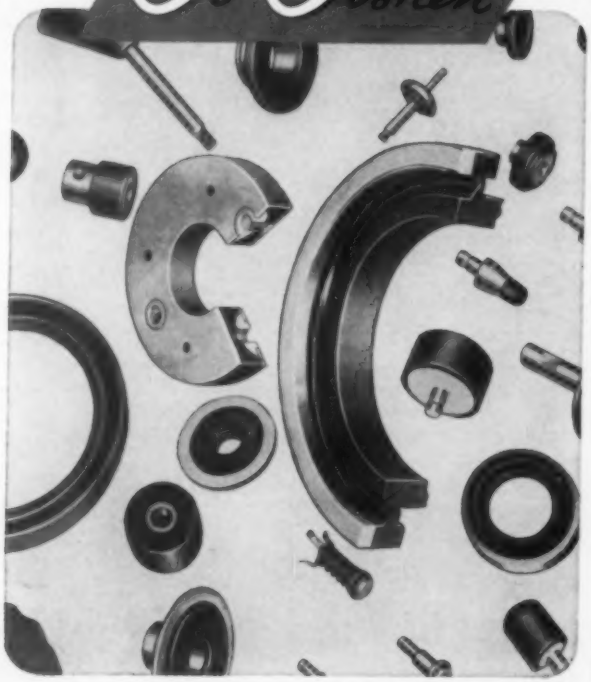

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Concluded from page 122

piston seal is pressure loaded to insure stiffness and meet friction requirements. The rod seals are MS 28775 O-rings with spiral Teflon backup rings. The cylinder bore and the piston are chrome plated to resist wear. Preloaded, double-row, self-aligning roller bearings at both ends of the cylinders eliminate backlash. A potentiometer mounted within the piston rod feeds back elevator or rocket motor position to the autopilot.

• **Motor drives**—Rudder and ailerons are driven by hydraulic motors through reduction gears. With gear reductions of about 800:1, the effect of hydraulic fluid compressibility on control surface flutter is greatly reduced. Inboard gear-drives support the hydraulic motor, a position potentiometer, and a tachometer. Inboard and outboard gear boxes are coupled by a torque tube with universal joints at either end. Outboard gear boxes are coupled to control surfaces with a crank arm.

Roll stabilization of the Bomarc is maintained with a special bulkhead whose attitude is kept constant within a few degrees of the horizontal by a hydraulic motor and gear drive. A pressure control servo valve modulates motor torque to overcome drive friction between the bulkhead and the missile body. Rate gyros on the bulkhead are used by the autopilot to limit the signal to the servo valve.

• **Servo valve test**—The flow control servo valves on the aileron, rudder, elevator, and rocket drives, and the pressure control servo valve on the roll stabilized bulkhead drive, are the components in the system most sensitive to fluid contamination. Because the hydraulic system reliability depends on them, an extensive test program for servo valve contamination resistance was undertaken. Using controlled contamination, valve hysteresis was monitored until failure occurred. The servo valves which demonstrated acceptable hysteresis vs. contamination level were then evaluated in the entire missile control servo loop.

• **Temperature**—Tests have shown that the hydraulic system operates satisfactorily at temperatures above 400 F. The static and dynamic seals fail at 500 F, the apparent high temperature limit of the system, and system performance drops below acceptable limits. An analysis of the horsepower requirements vs flight time shows that the system is not expected to exceed 420 F in flight. The maximum temperature usually will range between 300 F and 400 F. □□□

* *At the time this article was written, Mr. Tinius was with the Boeing Airplane Company, Pilotless Aircraft Division, Seattle, Washington.*

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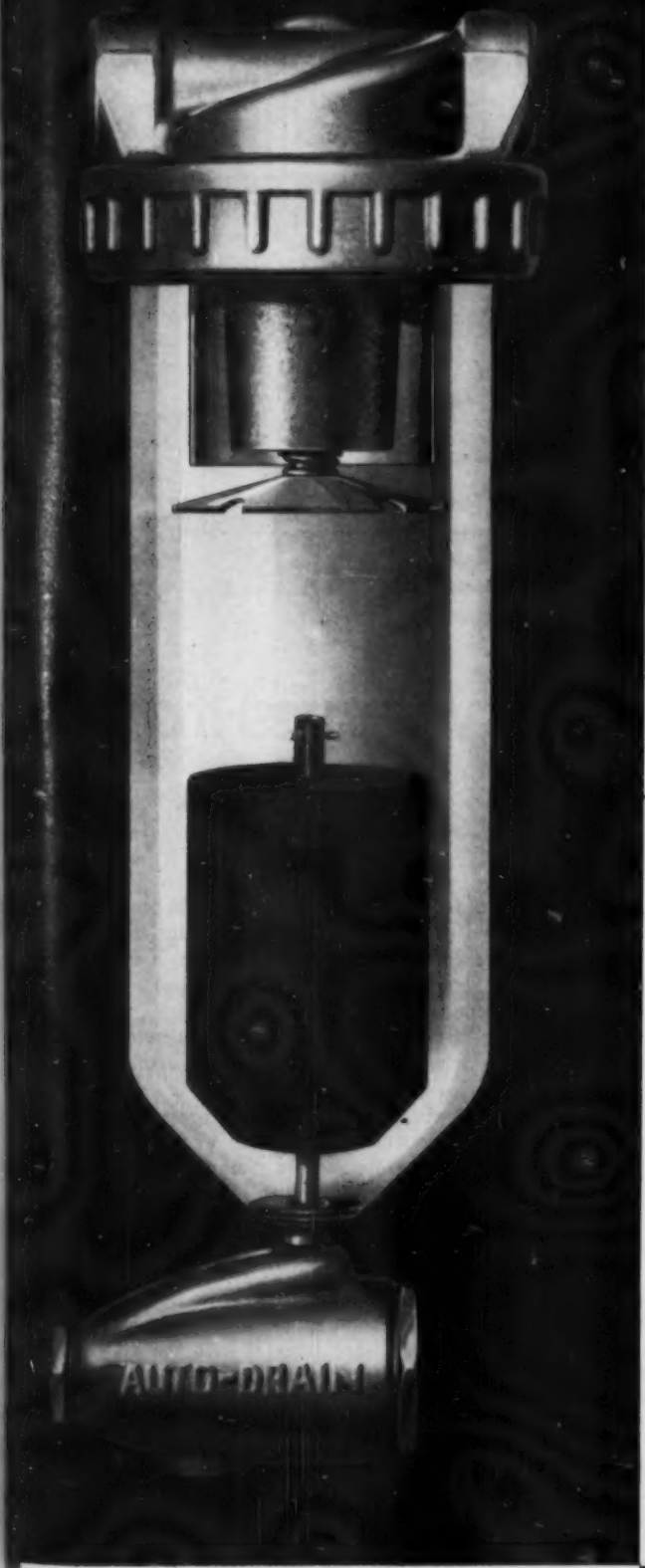


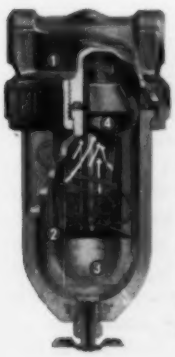
Watts "TORNADO ACTION" filter with new Automatic Drain

Designers — and users — of air-operated tools and equipment specify Watts filters because their superior filtering action and moisture-removing qualities have proved their efficiency. Now, with Watts' new automatic drain, you can have *truly automatic* filtering, too.

Watts "HIGH EFFICIENCY" filters remove condensate from air lines so effectively that draining of the bowl, in some instances, becomes necessary as many as three times daily. To meet the demand for labor-saving components, Watts has designed the "Auto Drain", a completely automatic drain filter which incorporates all the features found in the standard Series 602, 603 filters.

By use of the pilot principle, efficient and dependable removal of foreign particles and liquid condensate is attained. When liquid rises, the float admits air to the pilot valve chamber, opening a scavenger valve and allowing the trapped liquid and impurities to be blown out the drain opening.

Available in full range of sizes; ¼″ through 1″. Transparent bowls for pressures up to 150 PSI; metal bowls for pressures to 250 PSI.



How Watts "Tornado Action" removes condensate and dirt from air lines

Curved inlet ❶ directs incoming air in downward helical pattern. Larger impurities and condensate are "thrown out" by centrifugal action, collecting on bowl sides and spiraling downward past baffle ❷ into quiet chamber for draining-off. Baffle traps sediment in quiet chamber ❸ and allows only dry air centrifugally cleaned of larger impurities to reach filter element ❹ where finer particles are filtered out.

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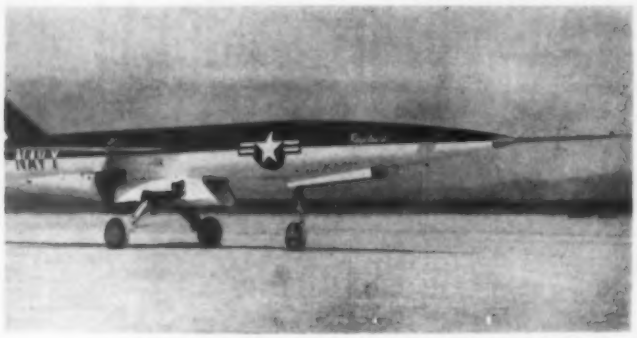
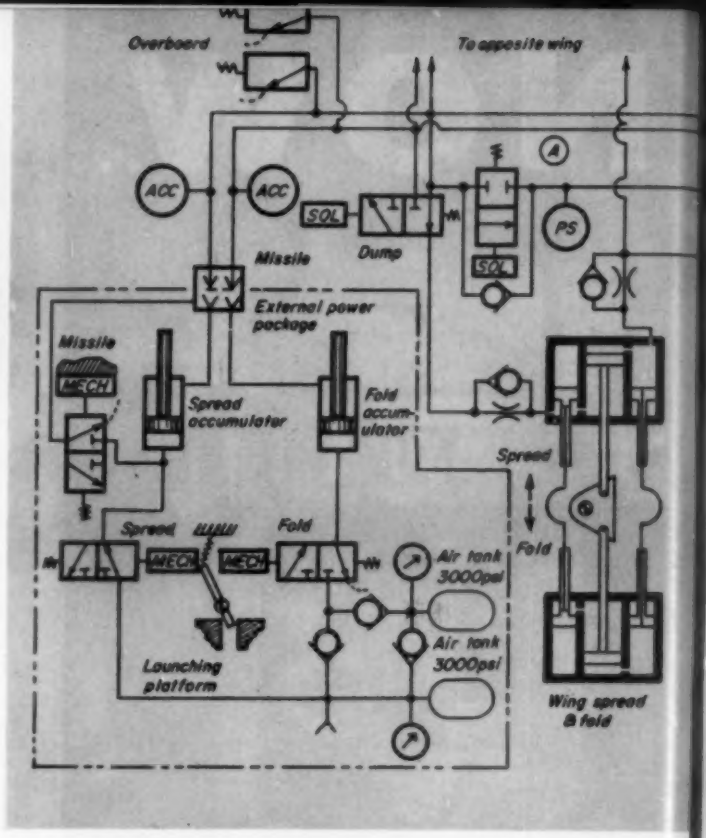


LANDING GEAR IS INSTALLED on Regulus test missiles to cut development cost. Only normal maintenance and servicing is permitted after a flight. In addition to air operations discussed below, the nose boom is pneumatically folded for storage.



3000-psi air systems for

• By C. G. BROCK, *Hydraulic Lead Designer, Chance Vought Aircraft, Inc., Dallas, Texas*

EARLY in the Regulus development program, a decision had to be made between hydraulic and pneumatic actuation for wing and fin folding, test missile landing gear, surface control, and brakes. After considering loading, cycling frequency, load reversals, rigidity required, duration of operation, and environmental conditions, an air-oil system was selected for wing and fin folding. Landing gear and brakes are pneumatic. Fine control for surface actuation required a hydraulic system. The following discussions of each system point up the reasons for these choices.

Life requirement of the hydraulic and pneumatic components is about 80 hours, based on 16 flight operations of 5 hours each including time in the air and on the ground. The components operate only about 20% of this time at maximum temperatures, so requirements for high temperature design are reduced.

Simplicity was stressed in designing the Regulus for maximum reliability. As few components as possible were used. All hydraulic systems have the same type of fluid to simplify handling and servicing. They are closed systems to prevent contact between air and fluid. No emergency air systems are installed.

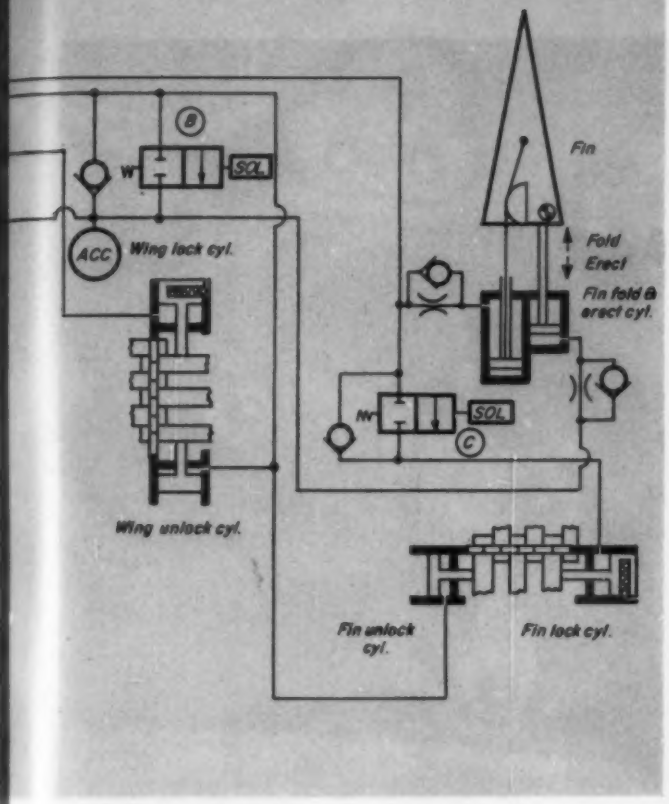
• **Wing-and-fin folding**—For compactness in storing the ship-based missile, the wings and vertical fin fold. Positive locking with a visual indication is required in the extended position. Operating time is limited to 15 seconds.

Because of the thin wing and fin panels, sequencing had to be by electrically operated valves rather than pilot operated valves or mechanical linkages.

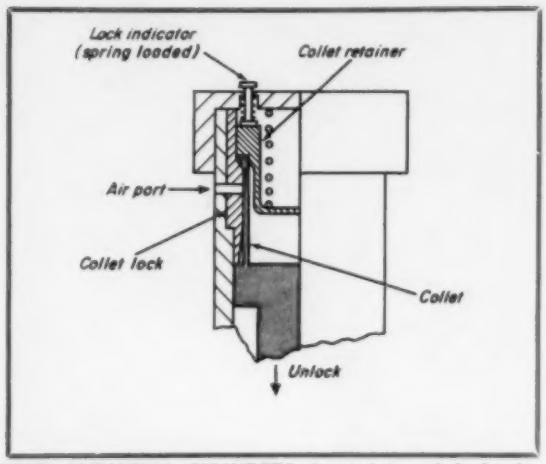
Two air bottles, charged to 3000 psi, pressurize piston type, air-oil accumulators. Because of booster action resulting from a difference in piston areas in the accumulators, the hydraulic system is pressurized to 3400 psi. During one cycle, air expansion drops system pressure to 3000 psi.

The actuators for the wings have two opposing cylinders as shown in the circuit diagram. Two flexible hoses which carry fluid between the cylinders are connected to pistons which are integral with the actuator cylinders. These pistons extend and retract to take up hose slack, because there is no room for folded hose.

The fin cylinder has a double piston. To erect the fin, one cylinder retracts, pulling up the fin by a cable. The other piston folds the fin to about 19 degrees



WING-AND-FIN SYSTEM spreads wings and erects fin. As missile is raised to firing position or lowered, launching platform actuates spread or fold valve. Solenoid valves **A** and **C** are energized after the wings are spread and the tail is erected. They connect fluid to the wing lock cylinder and the fin lock cylinder. Solenoid valve **B** is energized after the wings and fin are unlocked for folding. It connects fluid to the wing and fin folding cylinders.



GEAR ACTUATING CYLINDERS have internal locks to hold them extended. Collet deflects inward when engaging the collet lock. Before the collet is locked, the collet retainer deflects against the spring force. As the collet slips into the locked position, the collet retainer moves under it and locks it. A spring-loaded pin gives a visual indication that the cylinder is locked.

the Regulus

above horizontal. The piston attached to the cable damps this action. The pushing piston then disengages and the fin continues under its own inertia.

When the missile erects, the platform actuates the spread valve, pressurizing the spread accumulator and the spread system. The fold accumulator is vented through the fold valve. The wing panels spread and the fin erects. When each panel is in position, a limit switch actuates valves *A* and *C* which direct fluid to the locking cylinders.

In case of binding during erection, increased pressure actuates the pressure switch which energizes the dump valve to relieve cylinder pressure. If a launch aborts, the wings and fin fold automatically when the missile lowers.

• **Landing Gear**—Recoverability was a major requirement of the flight test missile to keep down testing costs. Because flights were planned for the dry lake beds of California, extendable wheels were designed for the test missile.

Gear operation is required approximately two minutes prior to touch-down to minimize aerodynamic drag. Maximum allowable operating time in flight is

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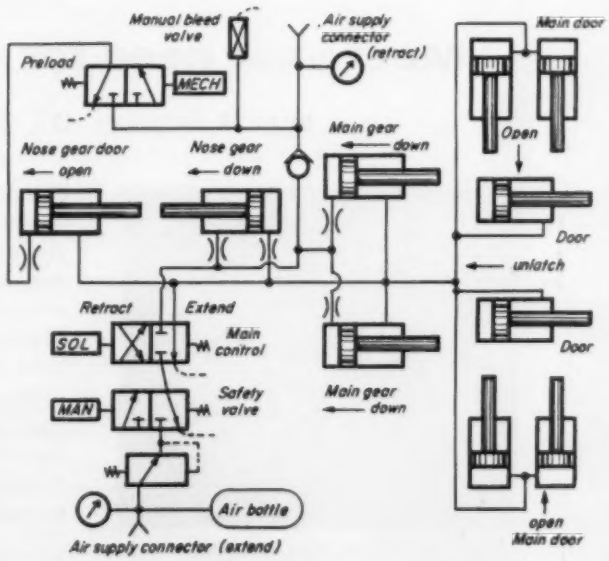

LANDING GEAR SYSTEM is controlled by 2-position main control valve which connects air to extend system venting retract system, or vents extend system. Preload valve connects air pressure to nose gear door cylinder to cushion it during opening. Main gear and nose gear cylinders are also preloaded from retract air connection.

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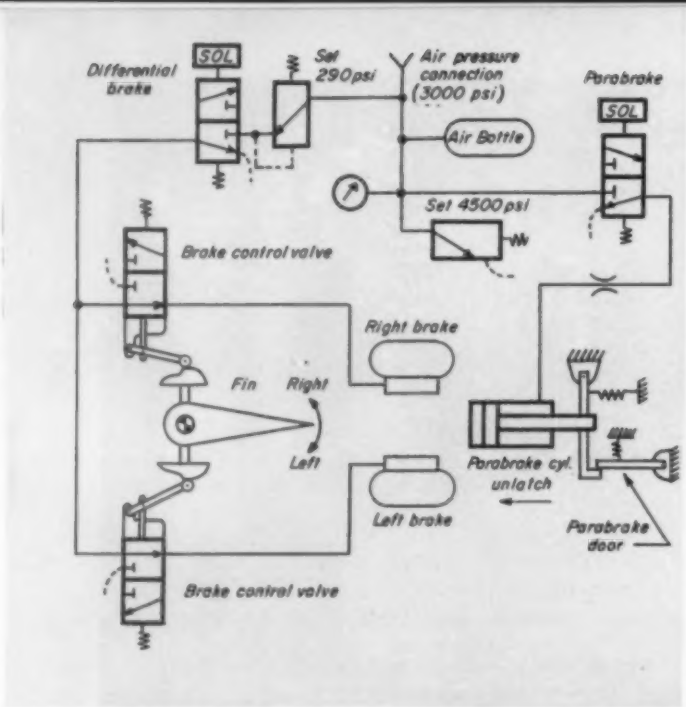


BRAKE SYSTEM releases parachute for initial deceleration after touchdown. Differential braking senses movement of fin to apply pressure to either brake or vent it through brake control valves.

30 seconds. When extended and locked in place, the gear has to withstand the high landing loads without assistance from the pneumatic system.

System pressure was selected as 1850 psi for optimum weight-vs-strength relationship. Aerodynamic heating results in maximum compartment temperatures of approximately 300 F. Calculations were made to convert operating time in flight under load, to operating time at sea level under no load. Flow control restrictors were adjusted to control operating time until it met the required limit. Calibration of these adjustable restrictors gave data for fabrication of fixed restrictors used in the missile.

The pneumatic system for retraction with manually closed doors is simpler than a full mechanical retraction system, because it requires no mechanical or pneumatic sequencing devices for door operations. Retaining air pressure gives cushioning during ground operation.

When the main control valve is shifted to *extend* position, all actuating cylinders are pressurized. However, the gear remains latched in the *up* position until the doors are opened. The doors are held closed by over-center mechanisms. A safety valve between the air supply and the main control valve vents the system to prevent inadvertent operation of the system. Each actuating cylinder has an internal lock to keep it extended.

With the missile on the launching platform and the gear extended, an external air supply is connected to the retract connection. When retracted, the gear engages up-locks. During retraction, the extend system is vented at the main control valve. The doors are closed manually. When the nose gear door is closed, a linkage opens the preload valve applying 1000 psi air presure to the nose gear door cylinder and the main gear cylinders for pre-loading. Pressure in the nose-gear door circuit is then reduced to 200 psi by bleeding through the bleed valve. These pressures are best for smooth ground operation.

• **Brake System**—Because of the low lift of the Regulus, it lands at high speeds, and initial deceleration is required prior to braking, to prevent tire blowout. The simplest way of slowing down is to release a parachute (parabrake).

Steering during deceleration could not be done by the rudder's deflections alone because of its small surface area. Another method is differential braking of the wheels. To do this, some mechanical motion must be monitored to signal which wheel brake should be pressurized. Since the hydraulic system operates the control surfaces even during reduced engine speed, the motion of the rudder is used to actuate valves controlling braking.

On touchdown of the missile, compression of the nose gear oleo strut actuates a limit switch which energizes the parabrake valve. This actuates the parabrake cylinder releasing the parachute which is pulled out by gravity and suction of the slipstream.

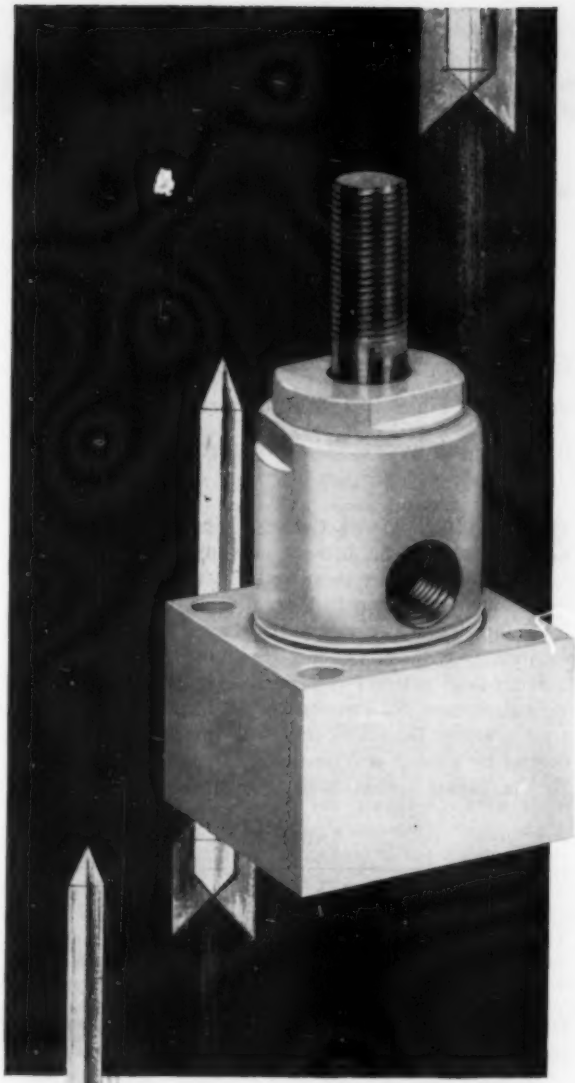
Three seconds after the parachute is released, the differential brake valve is energized admitting compressed air, regulated at 290 psi, to both brakes. As long as the missile holds a straight course, under control of the autopilot, both brake control valves remain open, and both brakes are applied equally. If the rudder moves 5 degrees or more to the left, the lever arm of the left brake control valve follows the larger radius of the cam and remains open. The lever arm of the right brake valve follows the cam's smaller radius and the valve shifts, venting the right brake. Action of the rudder to the right produces opposite actuation of the brakes.

• **Hydraulic Control System**—An autopilot-actuated hydraulic system positions two elevons and the rudder to control the missile's direction. It must hold the control surfaces rigid in any position, and move them under varying load conditions.

Pressure was established as 3000 psi, and cylinder sizes were calculated for the required force. Pump size was then determined from surface rates and cylinder sizes. An accumulator gives additional flow during maximum surface rates, and it also damps pressure surges.

Two pumps driven by the engine supply the system. Space limitations required two pumps rather than one larger one. The pressure compensated pumps deliver 14 gpm at 3750 rpm with a pressure cut-off range of 2900-3000 psi.

Before starting the missile engine, the reservoir and accumulator are pressurized to 35 psi and 100 psi respectively. In operation, the reservoir is pressurized by engine bleed air, but because this does not build up until about 30 seconds after the engine is started, the initial reservoir pressurizing is required to prevent pump starvation. □□□



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DESCRIPTION
Blind Flange Mounted
1" Bore
3/16" Stroke
Single Acting
1/4-18 NPT Pipe Port
Weight: 2 lbs., 4 oz.

TECHNICAL DATA	
Pressure Range	
Operating	0-1600 PSI
Surge	3000 PSI
Burst	6000 PSI
Force Factor	0.589
Volume	0.1107 cu. in. per stroke
Spring Rate	18 lbs. force installed 31.5 lbs. to compress

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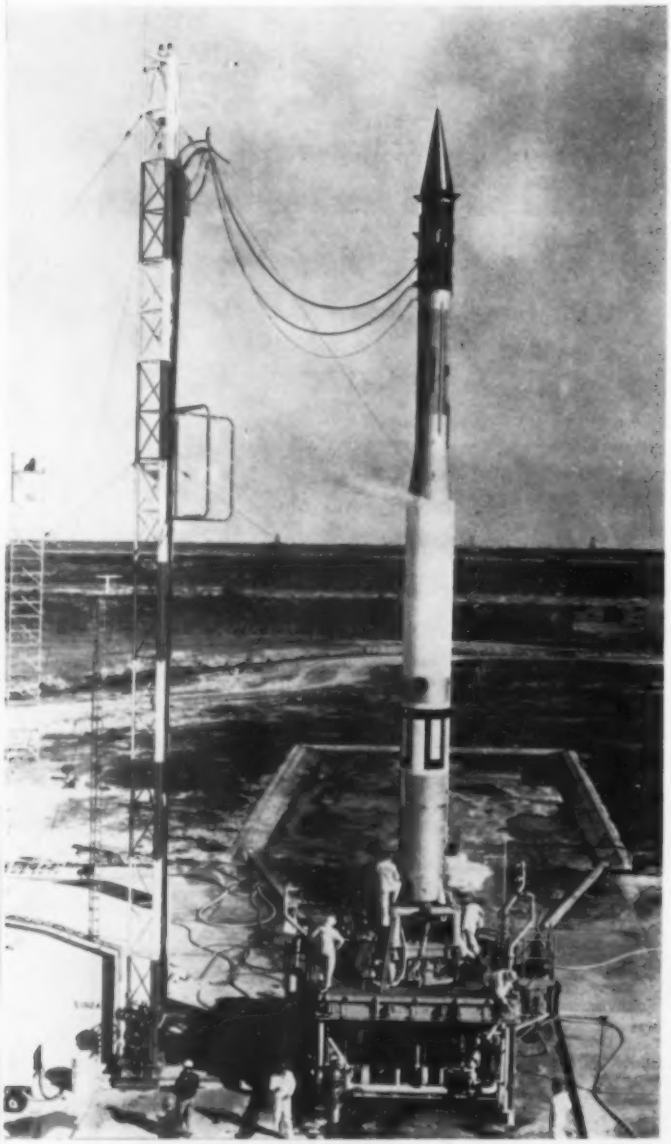
Servo valves control Vanguard

• By GORDON SCHOLES, *Martin Company, Baltimore, Md.*



VANGUARD PREPARES for launch. A pioneer in gimballed guidance, the rocket's hydraulic systems have shown high reliability.

Gimbal steering in rockets must be fast and accurate. Fluid stiffness is insured by close coupling of hydraulic components.

STABILIZING a rocket with a gimballed engine is like balancing a broom on your finger. As the broom tips, you have to move the bottom fast enough in the right direction to keep it from toppling over. Vanguard's first two stages are steered this way. The engines, free to swivel, are positioned hydraulically.

High fluid stiffness is needed to maintain accurate gimbal control. Shorter stroke and larger piston area tend to stiffen the oil column. The stroke and the load are set by gimbal requirements, as shown in Table I. By increasing piston area, system pressure can be reduced. Mounting the servo transfer valve directly on the actuator further reduces system sponginess.

TABLE I

Requirement	1st Stage	2nd Stage
Maximum engine deflection	±3.2°	±3.0°
Rate of deflection	30°/sec	20°/sec
Acceleration of gimballing	30 rad/sec^2	10 rad/sec^2

Actuator size is determined by loads due to thrust chamber inertia, gimbal friction, thrust vector misalignment as well as wind and side loads. Two actuators, 90 degrees apart, gimbal the thrust chamber in each stage in the pitch and yaw axes. The line of action of the actuators passes through the center of percussion to insure maximum structural stiffness.

• **First stage system design**—A bootstrap reservoir controls pump inlet pressure at high altitudes. This design uses the pump outlet pressure acting on a small area of a piston, to balance reservoir pressure acting on the larger piston area. System pressure is reduced for supercharging inversely to the ratio of the piston areas.

A constant displacement aircraft pump is driven by a 28-volt motor and delivers 2.5 gpm at 3500 gpm.

A constant displacement aircraft pump is driven by the gearbox on the H_2O_2 turbine that drives the propellant pumps. The pump delivers 2.8 gpm at 3900 rpm. A piston accumulator supplements pump flow and damps surges. Originally the supply line had a paper-element filter rated at 2-5 microns, but later rockets use a 13-micron, absolute, wire-mesh type which gives better filtration. High temperature O-rings

engine gimbals

seal the fittings because of fluid temperature of 200 F.

The actuators are double-rod, double-acting cylinders with spherical bearings in the rod ends to allow for gimbal motion. They are ruggedly constructed to withstand rocket engine vibration. An orifice of 0.024-inch diameter drilled into each piston damps the system. This damping could have been provided by controlling the leakage in the servo valve, but due to the experimental nature of the program, drilling the piston offered more flexibility in determining the required leakage rates. In the 2-stage flapper nozzle servo valve, spool position corresponds to an electrical input signal, and the gain is independent of supply pressure variations.

• **Second stage system design**—The second stage system is similar to the first stage. A miniature high-speed pump is driven by a 28 volt d-c motor. The reservoir is spring loaded for simplicity with very little weight penalty over the "boot-strap" type, since it is relatively small. No thermal relief valve is required with this type of reservoir. The damping orifice in the second stage actuator piston is 0.013" in diameter. The second stage engine fires a fraction of a second before stage separation occurs. This causes momentary rises in temperature and vibration. For this reason, stainless steel tubing is used throughout

TABLE II

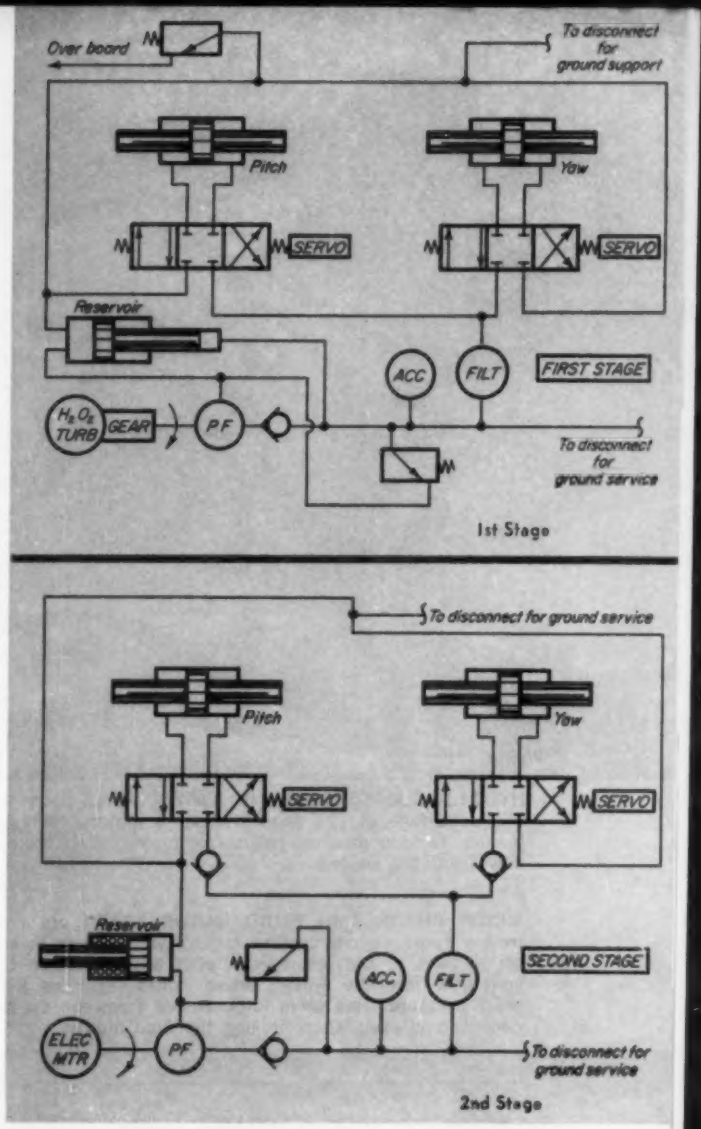
Size Range	Particles per liter
10-25 microns	21,500
25-40 microns	4,000
above 40 microns	2,700
fibers	130

the system. Check valves in the inlet to the servo valves keep control irreversible during high loads at separation.

• **Contamination**—A servo valve's reliability is a function of contamination. Laboratory tests determined acceptable particle distribution for these systems. This is shown in Table II.

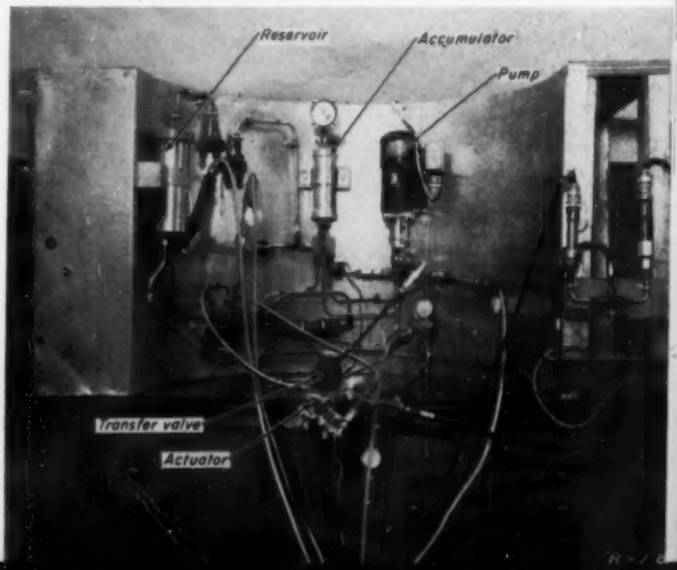
• **Testing**—All hydraulic components were tested under conditions of vibration, shock, acceleration, temperature and humidity. A vacuum test verified the feasibility of the unpressurized electric motor pump drive at hundreds of miles of altitude.

The hydraulic system was connected to a dummy gimballed engine and missile motion was simulated with an analog computer. Captive firings, closely simulating actual flight, were the most valuable tests. There have been no hydraulic system failures in eleven first-stage, and six second-stage flights. □□□



SIMPLE GIMBAL CONTROL circuits in the Vanguard. Piston-type accumulator uses pump pressure to balance reservoir pressure in first stage, and spring loading in the second. Servo valves are close to the actuators to stiffen the oil column.

LABORATORY MOCK-UP of second stage gimbal hydraulic control system. Instrument probes are shown scanning the simple, reliable circuit.



HYDRAULIC MOTORS drive the 20-foot radius boom on this centrifuge at 121 rpm. The same motors serve as brakes. To stop rotation, adjustable brake valves restrict flow from the motors.

MINOR CHANGES IN FLUID MOTOR SPEED are controlled by an adjustable flow control valve which bleeds off oil back to the reservoir. A pilot brake valve in the vent line from the system brake valves regulates their relief pressure. This valve is controlled from the master console and used when braking the fluid motors.

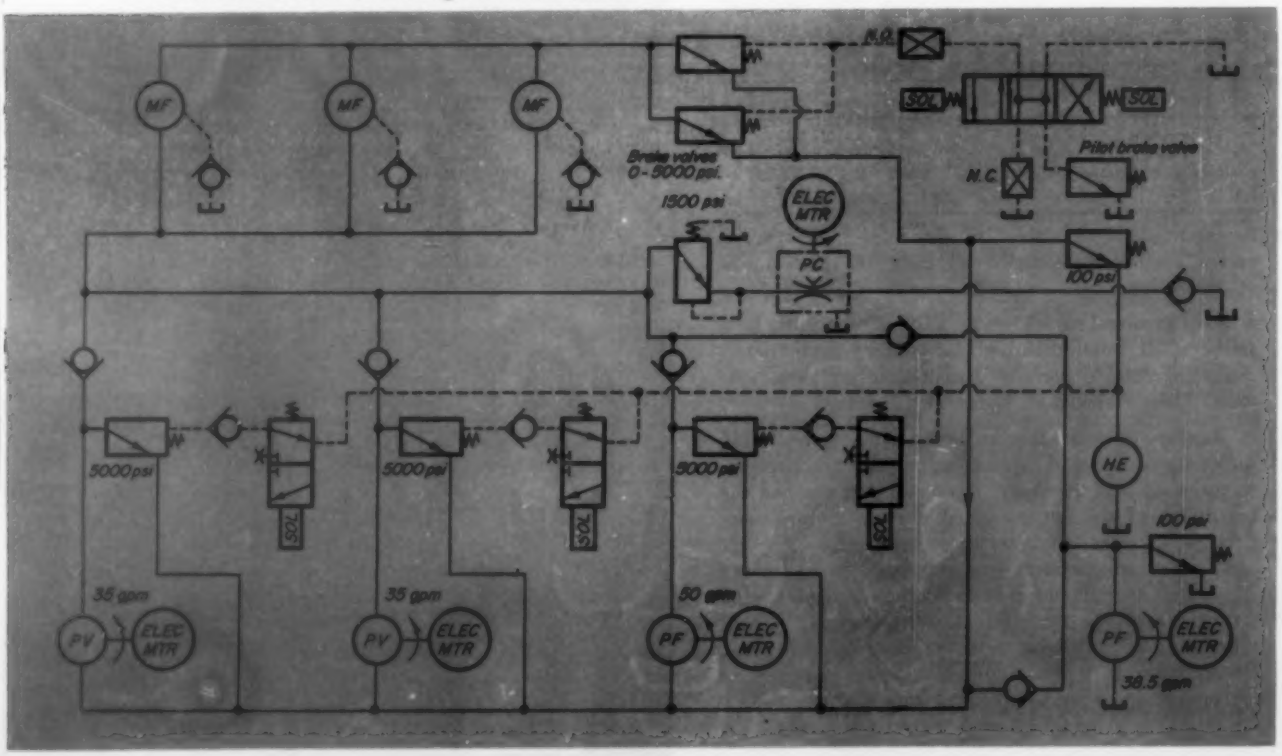
3 fluid motors rotate 100-g centrifuge

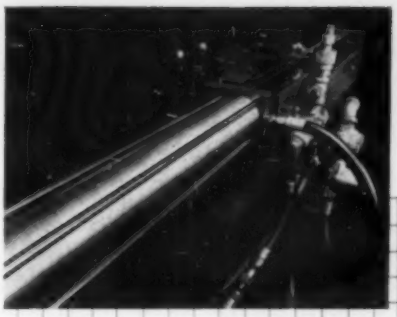
• By D. T. KUCZON and R. C. HINCK,
Test Engineers, Convair, a Division of General Dynamics

TO test missile components and assemblies under extreme g loads, The Rucker Co., Oakland, Calif. built this huge centrifuge to Convair's specifications. Three fluid motors rotate its huge beam. It whirls a 1-ton load at 121 rpm, creating a force 100 times the force of gravity.

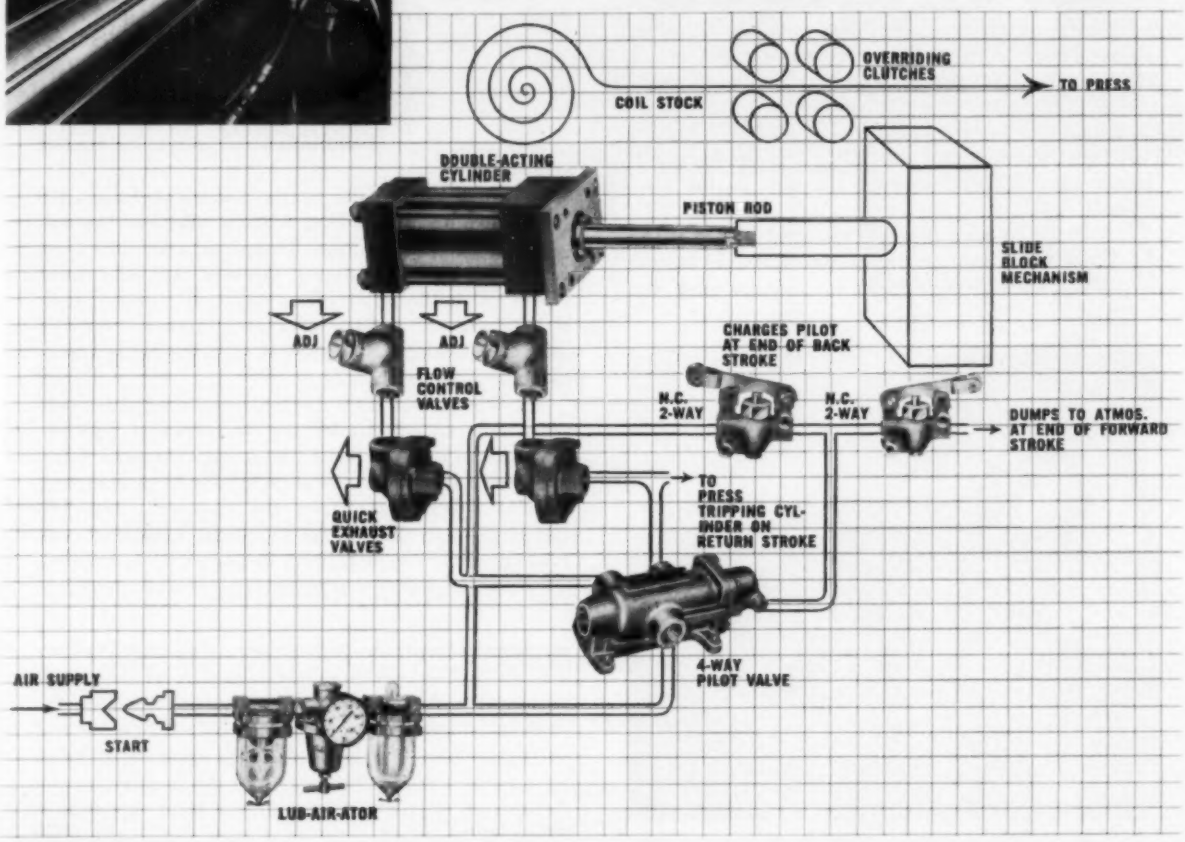
The hydraulic drive circuit is a closed loop with high pressure pumps driving fluid motors which rotate

Concluded on page 136





This is an example of how OEM use Schrader. The hookup of Schrader Air Products in the large schematic is used by the Cooper-Weymouth Company of Stratford, Connecticut, to operate its patented power press slide-feed. Power to the mechanism is supplied by a Schrader double-acting cylinder, the front head of which is machined as an integral part of the overriding clutch. At the end of the forward stroke, the slide block operates a normally-closed 2-way valve, which dumps the pilot of a 4-way control valve. This reverses cylinder piston, and the slide block mounted on it, to return for the next stroke. Another normally-closed 2-way valve ahead of the pilot charges the 4-way pilot in a conventional reciprocating motion arrangement to start the next cycle.



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3 FLUID MOTORS ROTATE CENTRIFUGE

the centrifuge. The fluid passes through the motors and returns directly to the pump suction. Variable-volume pumps control fluid flow to the motors. A make-up pump prevents cavitation of the main pumps.

Fluid temperature is controlled by continuously bleeding oil from the system through a heat exchanger. This bleed-off also provides a vernier speed control for the centrifuge by varying the flow to the fluid motors.

The 10-ton rotating boom is mounted in a concrete pit. Three fixed-displacement, piston-type fluid motors drive the boom through a 30:1 reduction ring and pinion gear. The motors operate from a common hydraulic manifold and deliver 387 hp to the boom at 5000 psi and 135 gpm. The motors are bi-directional with the reverse direction used as a brake for the boom.

MASTER CONTROL CONSOLE gives complete operational control of the centrifuge and indicates pump volumes and pressures, centrifuge speed, hydraulic and auxiliary braking, and trouble such as high temperature or lube oil failure.

TWO VARIABLE-VOLUME, and one constant volume pump supply 5000-psi pressure to the hydraulic drive motors on the centrifuge. Electric motors totaling 400 hp drive the pumps. Output from the variable-volume pumps is controlled from the master control console.

• **Power Source**—Fluid is supplied to the motors by one constant-volume and two variable-volume, 5000-psi pumps. Electric motors with a total of 400 hp drive the pumps. They can operate alone or in combination, depending on system demand. Output from the variable-volume pumps is adjusted at a remote control console.

A vented relief valve in the discharge from each pump permits it to unload without affecting the output from the other pumps. Three-way solenoid valves, actuated from the control console, vent the relief valves. With the relief valves open, all pumps can be started and on standby so that maximum power is available. Check valves prevent oil from being forced through idle pumps.

A motor-driven, fixed-displacement, gear pump supplies make-up oil. It delivers 38.5 gpm at 350 psi. Its pressure is controlled by an adjustable relief valve. An interlock prevents the main pumps from operating without sufficient flow from the make-up pump. The pump also supplies oil to the fluid motors during braking. Since the motors act as pumps while braking, they must be supplied with fluid to prevent cavitation.

• **Speed Control**—A continuous bleed-off allows a small flow of hydraulic fluid to pass from the closed-loop system to the 350-gallon reservoir through the heat exchanger. A pressure-compensated flow control valve regulates this bleed-off. This valve is adjusted by a selsyn motor controlled from the remote console. A pressure reducing valve in the system serves as a safety valve, since pressure surges can reach 5000 psi. This valve limits the pressure of oil entering the flow control valve to 1500 psi.

The heat exchanger limits oil temperature to 120 F. An automatic temperature regulating valve controls water flow to the heat exchanger.

• **Braking**—To stop the centrifuge, the main pumps unload, and flow from the motors (now driven by the rotating boom) is restricted. Brake valves which can be adjusted from 0 to 5000 psi provide the back pressure. A pilot brake valve in the vent line from the brake valves can be adjusted for deceleration.

An air-actuated friction brake stops the centrifuge in an emergency, or if hydraulic pressure fails. The brake has an 8-foot diameter band which works on a drum rotating with the centrifuge. A solenoid valve operated from the master control panel actuates a pneumatic cylinder which forces the band against the brake drum.

If the centrifuge speed exceeds 125 rpm, an overspeed relay trips the control circuit. □□□

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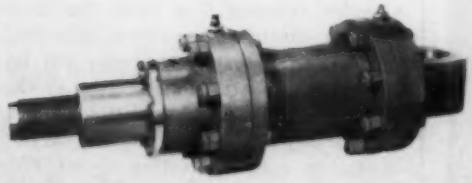

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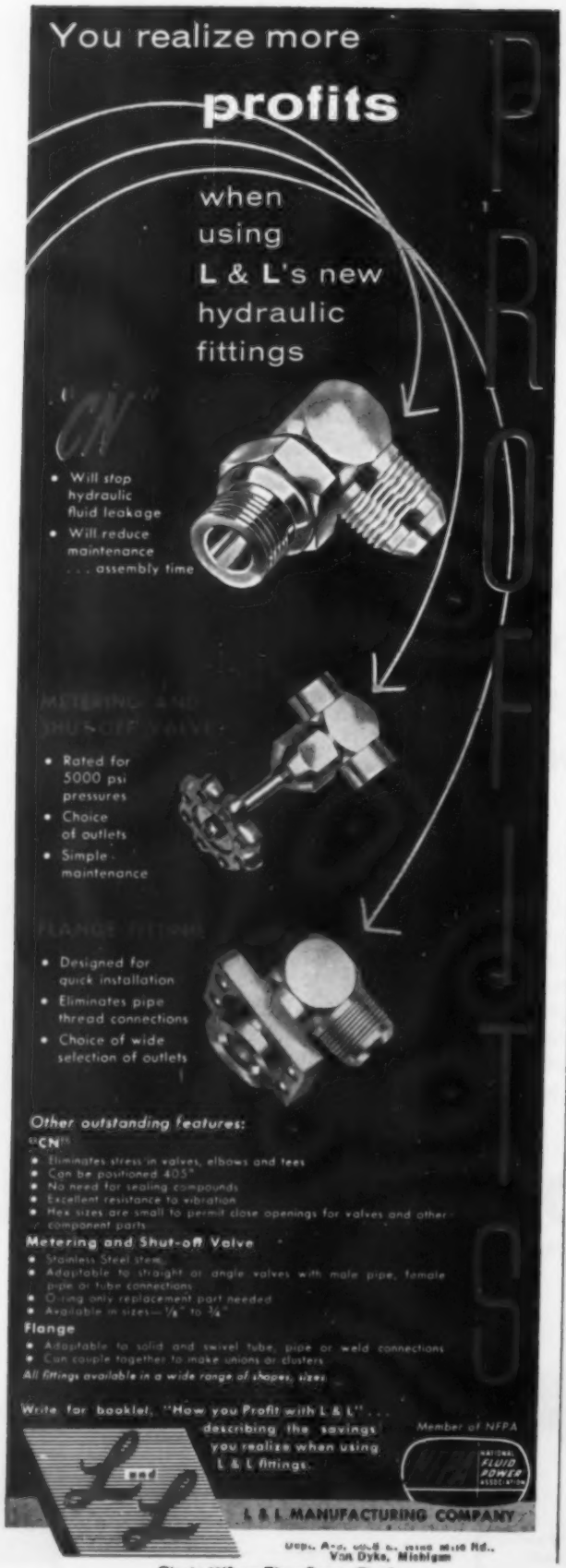
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Concluded from page 89

by a 20 hp electric motor recharges the accumulators over a 10-minute period. A bank of 12 collapsible-bag type accumulators charged to 3000 psi supply high power demands for short periods. The fluid is MIL-0-5606.

This energy can be stored for instant use with little pumping required during the actuation period. Each accumulator has a manual shutoff valve to disconnect it from the system in an emergency. For replacement, air is bled from the accumulator through a bleed fitting.

Distribution lines to the launching apparatus may be isolated by shutoff valves.

Control valve pilots are operated by aircraft solenoid valves. Where flow rates are about 200 gpm, industrial control valves are used. Aircraft valves are preferred for smaller flows, because they are more reliable. Nitrogen valves for the accumulator banks are manifolded according to the system they supply.

Controls and pressure gages are grouped on a panel. Hydraulic control valves are manifolded in functional groups with manual shutoff valves clustered nearby.

The package is arranged with equipment on 3 sides, with the fourth open for access. Skid design permits easy portability and replacement.

• **System actuation**—Aside from roof actuation there are five separate actuating functions:

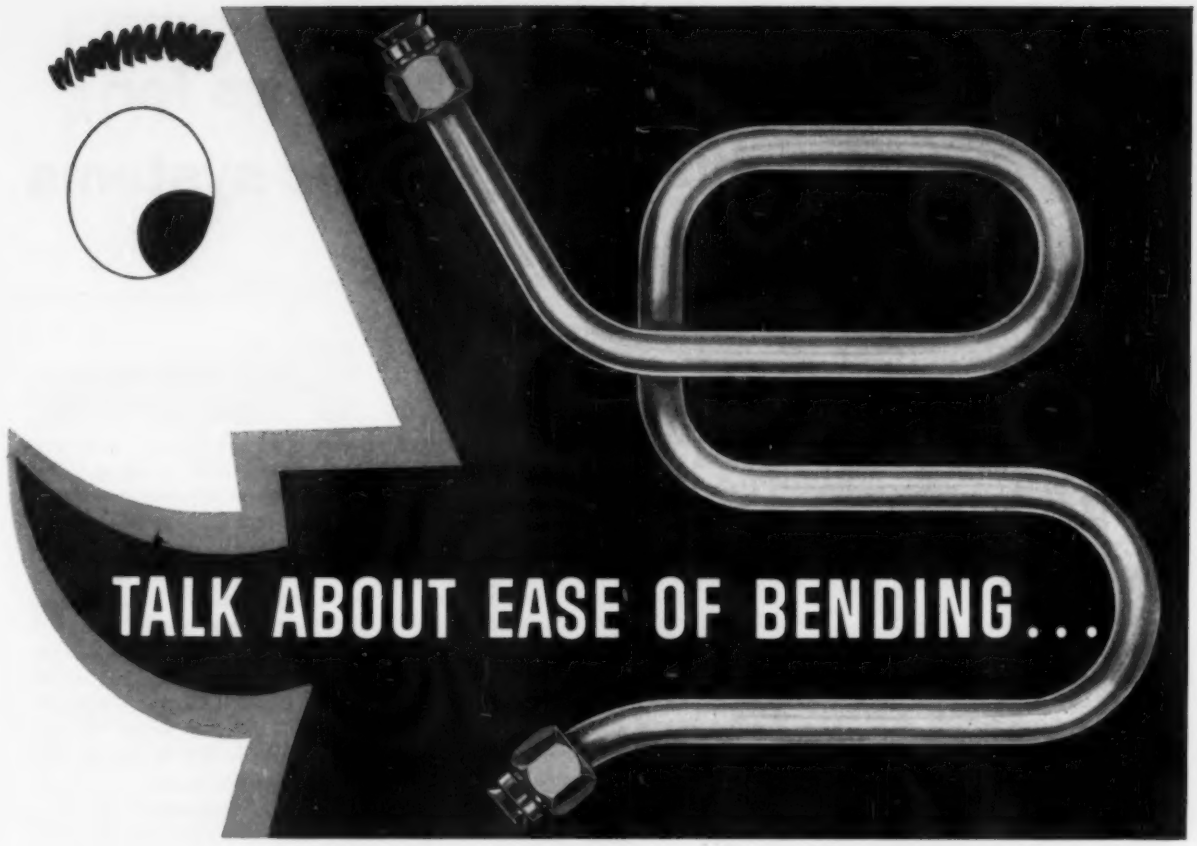
Missile erection
Wind restraint arms
Nose clamp
Boom-to-carriage lock
Carriage-to-base clamp

When the "fire up" signal is given, the launcher main shutoff valve opens and supplies pressure to the launcher manifold. At the same time, the roof actuation cycle begins. Next, the missile boom is erected by its cylinder. With the missile in the vertical position, the carriage-to-base clamp is tripped, securing the carriage to the launcher base. Two cylinders open the nose clamp, while another releases the carriage-to-boom lock. A pilot valve then reverses the position of flow from the erector cylinder control valve, pressurizing the rod end of the cylinder. This starts retraction of the boom assembly and triggers a circuit which launches the missile when the boom reaches a predetermined position.

The first motion of the missile opens release valves in the wind restraint arms circuit. This pressurizes the cylinders and the restraint arms are freed for rapid action by compressed springs.

After a time lag, the pilot valve of the erection cylinder reverses flow from the control valve and supplies oil to the erection cylinder. This elevates the boom, so that the missile will be supported in case of a misfire. During this event, the boom is locked to the carriage and the nose clamp is closed.

Once the missile is fired, the carriage-to-base lock is opened, and the erection circuit is reversed, lowering the boom. Also, the roof moves to the closed position. The hydraulic pump then recharges the accumulators to ready them for another cycle. □□□



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Design parameters for missile hydraulic systems

• By H. D. DAVIS, *Senior Design Engineer, Convair-Astronautics Division of General Dynamics Corp.*

DEVELOPMENT of the supersonic airplane and the guided missile created a revolution in aircraft hydraulics. High velocities of supersonic airplanes have greatly increased the forces required on the flight control surfaces. Since the pilot can't produce these forces, power assistance is needed. The guided missile also needs power assistance, since signals received from the combined autopilot-guidance system are too weak to actuate the flight control surfaces.

Hydraulics has many advantages for power assistance. No other method can receive power from a prime source up to 50 hp, and convert it to closely controlled, highly responsive, low-speed linear or rotary motion.

The hydraulic system is no longer the simple, brute force system for positioning landing gear and flaps. It must operate continuously with variable power output and respond quickly and accurately to delicate input signals.

Some of the conditions which affect future design of missile hydraulic systems are temperature, vibration, g loading, operational life, weight, reliability, and cleanliness.

• **Temperature**—The powered flight time of a missile is very short compared to conventional aircraft. Air-to-air missiles operate in flight for only a few seconds, and the largest intercontinental ballistic missiles are powered for less than 10 minutes. But during these periods, environmental temperatures may range from —425 F to 2500 F.

Liquid propellant rockets create the greatest range of temperatures. Proposed missile propellants are liquid hydrogen with a boiling point of —425 F, and liquid oxygen with a boiling point of —297 F. Hydraulic systems to control fuel valving may be exposed to these temperatures. Valves now used for this service have their actuators remotely located from the main body of the valve. A mechanical linkage connects the two. In some cases, fluid is bypassed through the valve actuator and pilot valve to warm the system. This design is heavy and power consuming.

Military temperature specifications for in-flight and launcher hydraulic systems are shown in Table I.

TABLE I—MILITARY SPECIFICATIONS FOR MISSILE AND LAUNCHER HYDRAULIC SYSTEMS

Class	Temperature Range
I	—65 F to 160 F
II	—65 F to 275 F
III	—65 F to 400 F
IV	—65 F to 1000 F

Many hydraulic components don't meet these requirements. Servovalves will not operate within specifications below —20 F. O-rings do not cover the range of —65 F to 275 F. Fluid viscosities change greatly.

Therefore the designer must heat at low temperatures, cool at high temperatures, and provide environmental enclosures.

Multi-engine rockets have large areas of the aft end of the boat-tail exposed to engine radiation and aerodynamic turbulence. The resulting high temperature affects the equipment inside. On the Atlas missile, a heavy fire shield was added to the boat-tail. Also Fiberglas boots had to be used around

Continued on page 142

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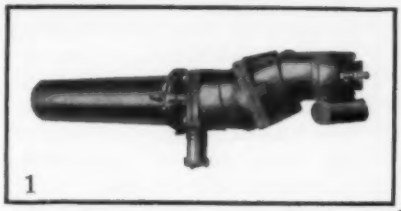
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Missile progress demands unquestionable reliability, maximum efficiency and compatibility of the system with the overall vehicle. These rigid standards are being met by Vickers with *missile industry-tailored* R & D, engineering, production and service capabilities blended with extensive experience gained from a large number of successful accessory applications on a majority of the current production missiles.

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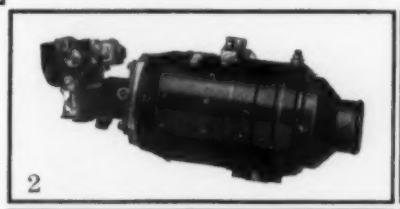
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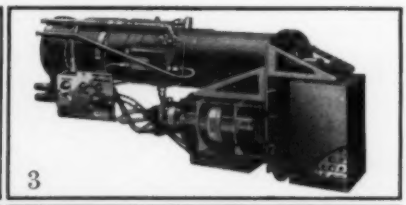
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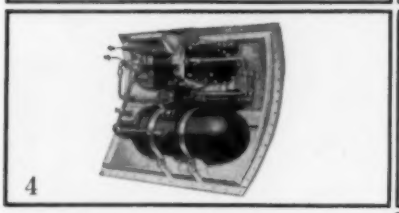
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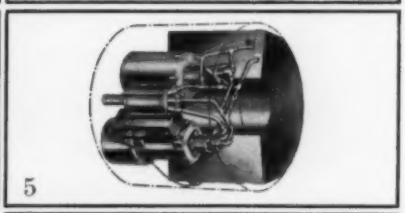
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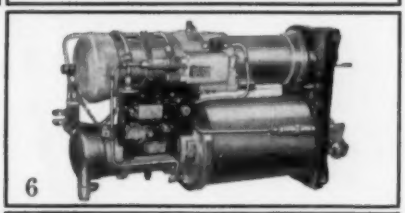
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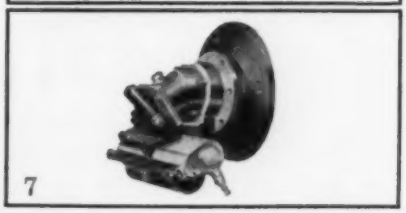
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the moving thrust chambers to protect components in the engine compartment.

In missiles operating beyond the atmosphere, heating is increased by over-expansion of the engine exhaust flame. The entire aft section of the missile may be bathed in the flame. Heat transfer rates can reach 100,000 btu/sq ft/hr with temperatures as high as 1500 F on component surfaces. Aerodynamic heating may cause skin temperatures to reach 2500 F (melting point of steel).

Materials of high strength, high temperature resistance, and low thermal conductivity are needed for hydraulic components. Recent developments in plastic materials show some promise.

System power loss is also a factor in adding heat. The average missile hydraulic system is only 50% efficient. This means that considerable heat is added to the hydraulic fluid. For this reason, the designer must determine component efficiencies. Pumps must be at least 90% efficient. Servo valves with flat P/Q curves should be specified, and valves and orifices kept at a minimum.

The one unique factor in missile hydraulic systems is the short duration of powered flight. This permits design on the basis of transient heat exchange rather than steady state. Reservoirs and heat exchangers can be smaller than would be required for long durations.

• **Vibration and acceleration** —Most hydraulic components operate at high power levels and missile acceleration has little effect on them. However, vibration causes rapid fatigue of structural parts, destroys O-rings, and chatters moving parts. Little is known about the relationship of vibration of fatigue and static strength properties of materials. This lack of information often results in poor design on the drawing board and failure in laboratory and flight testing.

Current specifications for vibration testing of components fall between 1 and 5000 cps of sinu-

Continued on page 144

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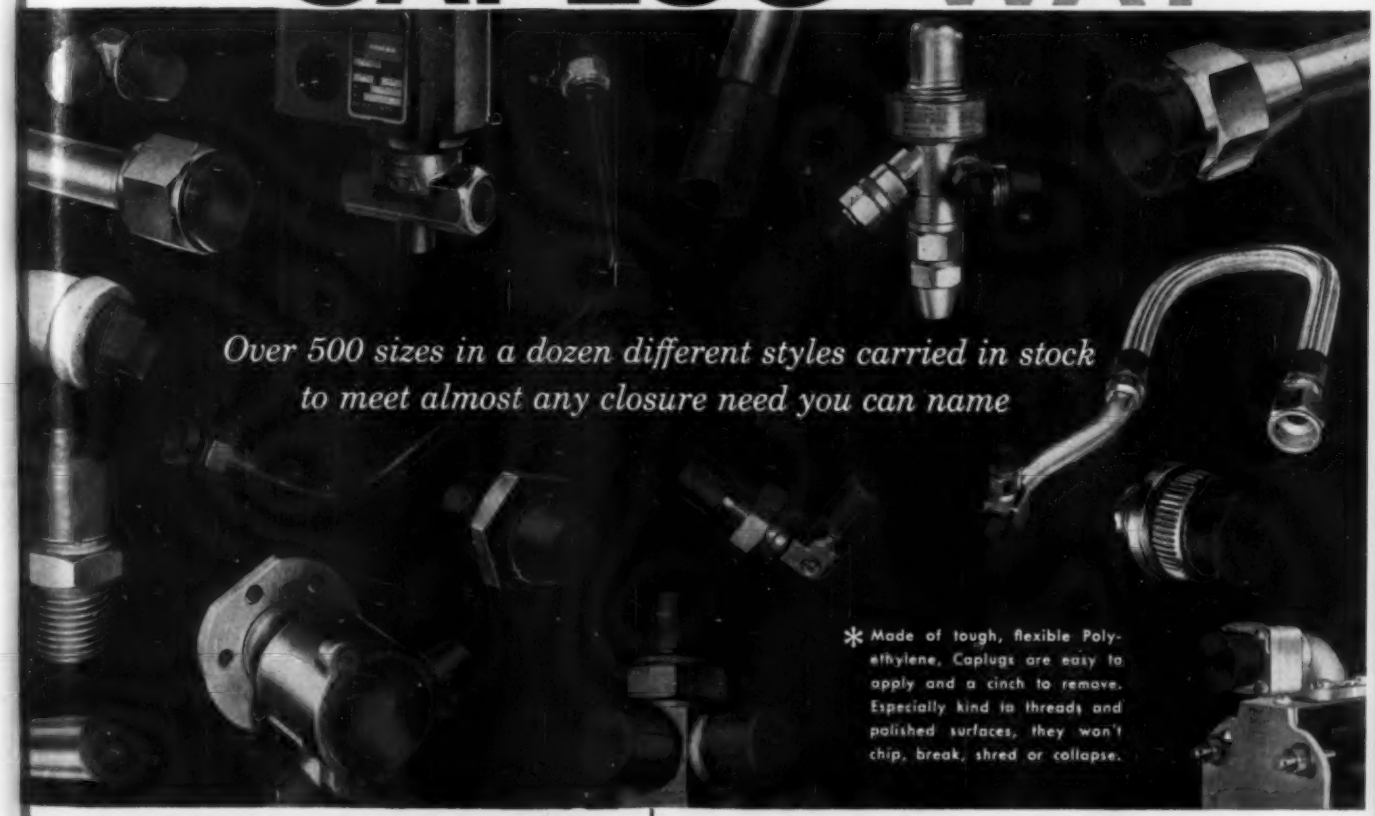

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soidal vibration at a maximum of 100-g acceleration. The future trend is toward reduced sinusoidal vibration, but with superimposed random vibration. Comprehensive military specifications for vibration testing are needed. They would give component manufacturers a more firm footing for designing and testing hydraulic components.

• **Operational life**—Life testing is the most common cause of failure in hydraulic component testing. Aircraft components require considerably longer life cycling than missile components because of the longer operational life of airplanes. At present, missile life requirements are based on arbitrarily selected values, or on operational experience.

Military specifications should be established for life cycling *missile* components. The components could then be designed for missile life rather than the much longer airplane life.

• **Weight**—Power sources are among the first targets for reducing weight. Liquid propellant rockets need high-speed, high-efficiency pumps, which can be driven directly from the propellant pumps at speeds from 5000 to 50,000 rpm. Solid propellant rockets need lightweight, electric motor-pumps, or mechanical, accessory power units.

Weight can also be saved by packaging components. An example is the engine position actuators on the Atlas. Five components were used with each actuator: a cylinder, a servo valve, a feedback transducer, a flow limiting valve, and a filter. In the original design, the cylinder, servo valve, and feedback transducer were assembled together. The filter and flow limiter were separate. All units were designed to aircraft standards and weighed 23 lbs. In a later design all five components were packaged in one unit designed to the specific life of the missile. Weight is less than 12 lbs.

To date, no exotic materials are used in missile hydraulic systems. However, conventional materials

Concluded on page 146

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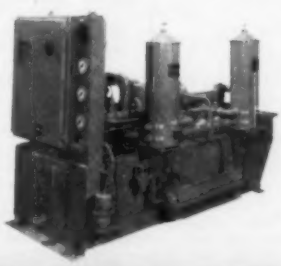

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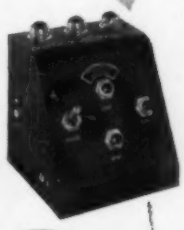

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have many drawbacks. Metals offer a problem because of high coefficient of heat transfer and low specific heat. Plastic materials are being tested for component housings and manifolds. Components may be sheathed in plastic materials which act as thermal barriers and eliminate the weight of elaborate heat shielding.

• **Reliability**—Missiles use only one hydraulic power source. There is no secondary or emergency system. Every component must work within specification limits every time it is operated or the missile will fail in flight. Few components at present are tested for reliable operation. Seldom is every cycle of a life test studied for sub-standard operation, and seldom are components tested for combined environments. These factors are important to establish a component confidence level.

• **Cleanliness**—The most controversial, elusive, and expensive factor in missile hydraulics today is cleanliness. Some companies using great care in maintaining clean systems have had miserable flight failures. Others, using only minimum precautions, have had no failures directly attributed to contamination. Dealing with contamination is a growing pain of the industry. As hydraulic systems get more complex and more stringent dynamic requirements are imposed on them, the need for contamination control will increase. We may find a better way to deal with contamination in the future as acceptable contamination levels are established for specific components, and standards and methods of measurements are fixed.

Convair-Astronautics has set 30 microns as the contamination limit. We feel that sterner requirements are not obtainable. We use filters that remove particles larger than 30-microns from fluid entering critical components. Photo micrographic records are made from fluid samples removed from tubing and components during manufacture. Parts are handled in dust-controlled areas prior to installation in the missile. □□□

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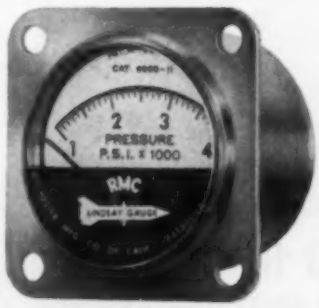

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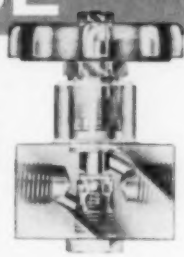

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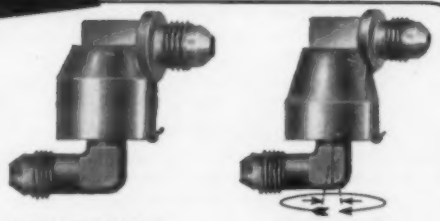

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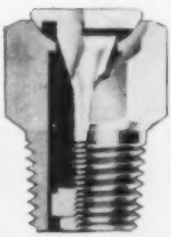

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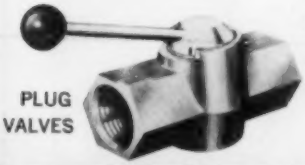

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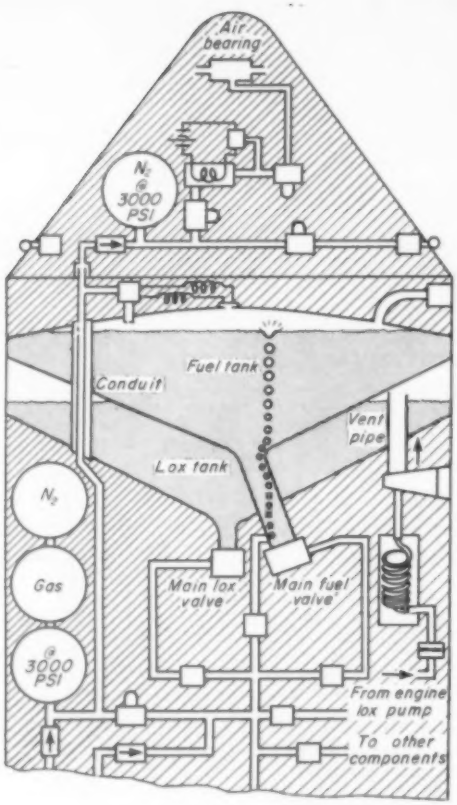
In-flight fluid power on the Jupiter

• By ZELMAR BARSON, *Staff Engineer, Propulsion Systems Design Section, Chrysler Corp., Missile Division, Detroit, Mich.*



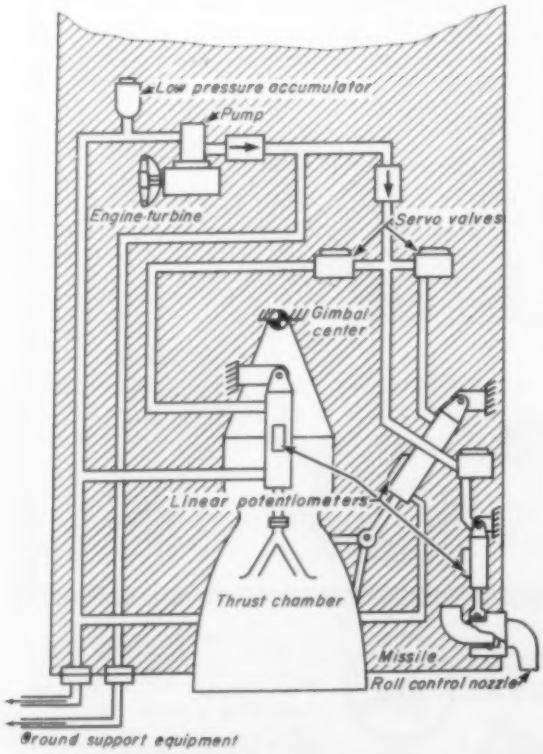
Pneumatic system—The Jupiter has two, inter-connected pneumatic circuits, one in the thrust unit and the other in the missile. The thrust unit pneumatic system actuates valves, pressurizes the fuel tank, and agitates the fuel. The missile pneumatic system controls the missile in space after separation and lubricates an air bearing in the stable platform of the guidance system.

In the missile, nitrogen is held in lightweight fiberglas storage spheres at 3000 psi. Steel spheres had been used in the past, but fiberglas proved lighter and more reliable.

Fuel tank pressurization uses 3000 psi directly, controlled by a pressure switch which operates a normally-closed solenoid valve in the pressurizing line. Most of the pneumatically actuated components use 750 psi. One pressure regulator supplies 750-psi air for the thrust unit components. Another regulator is used in the missile. The main propellant shutoff valves, fill and drain valves, tank vent valves, and vent valve lock are all pneumatically operated.

After the missile separates from the thrust unit, the 750-psi missile supply controls its orientation during ballistic flight. Jet nozzles mount on the periphery of the missile for attitude and roll control. They are supplied with nitrogen through quick-acting solenoid valves actuated by signals from the guidance system. Opposite pairs of parallel nozzles actuate to control attitude. Four nozzles facing in the same direction as rotation, control roll.

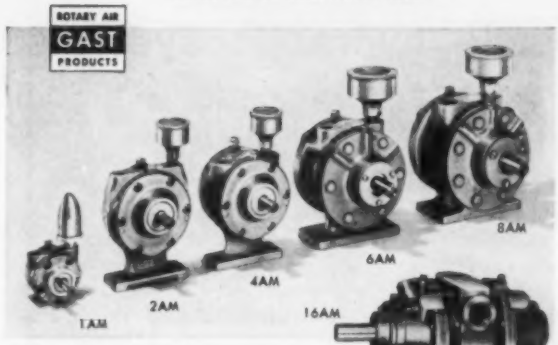
Nitrogen at 60 F expanding adiabatically from 3000 psi to 750 psi would be cooled to −110 F. For many components using rubber seals, this temperature would cause malfunction. To counteract this temperature drop, immersion heaters are installed in the storage spheres. They are thermostatically controlled to keep the temperature of the nitrogen at about 100 F.



Hydraulic system—A 1.5-gpm, 3000-psi, axial-piston, variable-volume pump powers the hydraulic system on the missile. A power take off from the main turbopump gear box drives the pump at speeds to 3700 rpm. The pump stroke adjusts for required output.

Double-acting, equal-area, linear actuators gimbal the main rocket engine in two planes for directional control during the powered phase of the flight. A similar actuator rotates the turbine exhaust nozzle for roll control. A separate 2-micron filter is installed on each actuator in addition to system filters.

Circle **62** on Time-Saver Card



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8. Top-quality ball-bearing design.

TYPICAL PERFORMANCE		
Model No.	H.P. at 90 PSI 2000 RPM	Weight lbs.
1AM	0.13	1½
2AM	0.57	5½
4AM	1.1	8
6AM	2.0	17
8AM	4.0	25
16AM	7.0	65

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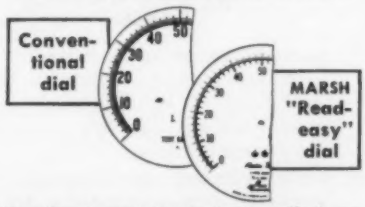
Unprecedented accuracy and dependability in test gauges developed to meet today's exacting requirements. Each gauge individually *dead-weight tested!* Guaranteed accurate within ¼ of 1% plus or minus of maximum dial reading over entire range.

Mirror dial also insures accurate "dead-on" reading.



New "Read-easy" dial (patent pending), as illustrated above, assures reading accuracy in keeping with indicating accuracy. Also note three advanced means of reading available in all "Master-test" gauges: twin-tip pointer, mirror dial, and "non-parallax" dial as shown opposite.

Sizes 4½", 6", 8". All standard pressure ranges 0-15 psi to 0-30,000 psi, vacuum and compound.

"Non-parallax" dial has Plexiglas insert that assures accurate reading even when read at angle.

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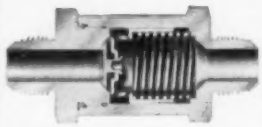
Circle **100** on Time-Saver Card

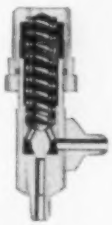
ground support and test equipment

REPUBLIC VALVES



FREE-FLOW CHECK VALVES
No leakage. 3000 psi. Very low pressure drop. Can be furnished to open at ¼ to 35 psi. Brass, stainless steel, or aluminum alloy. ⅛" to 2" pipe or tube. Temp. range -65° to 200°F.

RELIEF VALVES
Quick unloading, smooth operation. Guided shut-off piston with stainless steel or Nylon seat. Pressure range to 4000 psi. Brass, aluminum alloy, or stainless steel. ⅛" to ¾" pipe or tube. Temp. range to 400°F.



HAND PUMP
For hydraulic applications on missile carrier and support equipment. Double-acting. 2 cu. in. displacement per cycle. 1000 psi. working pressure. Aluminum alloy body, stainless steel trim. -65° to 160°F.

LEVELATOR VALVE
For automatically maintaining height and level condition in any vehicle with air spring suspension. Controls swaying in transit, and off-level position while standing. Applicable to trucks, buses, trailers, carriers, cranes, etc.

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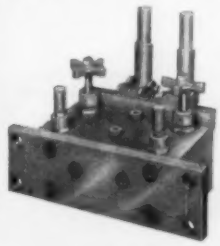
Smooth, easy operation, with low turning torque because of pressure balancing design. 0 to 6000 psi. Bronze, steel, or aluminum alloy. ⅛" to 2" pipe or tube. 2, 3, 4 ports.



DUAL HAND PUMP
2 pumps, 2 relief valves, and 2 needle shut-off valves, compactly manifolded for elevating mechanisms, hydraulic applications on ground support equipment, etc. Aluminum alloy body, stainless steel trim. -65° to 160°F.

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Circle **132** on Time-Saver Card

Long term storage for missile hydraulic systems

• By M. VOYTISH, Jr., *Group Engineer, Auxiliary Power & Controls*
Convair, A Division of General Dynamics, Pomona, Calif.

DESIGNERS of missile hydraulic systems worry about weight, high temperatures, short life expectancy, and loading. However, if the system binds or leaks after being stored for a few years, all their careful designing goes down the drain.

Many missiles are stored up to five years and must be launched without taking time to flush, fill, or bleed the hydraulic system. Here are some important component considerations for missile hydraulic systems that must be stored *ready for use.*

Sump should be a low-pressure, bellows type for temperature compensation and pump inlet pressurizing. Low pressure system should be sealed in a container which also holds the high pressure system. Use helium to check for leaks before filling with fluid.

Accumulators should have a spring-loaded steel diaphragm to avoid piston seals and gas leaks. Diaphragm accumulators give high effective spring force for small volumes. Avoid gas charged accumulators.

Variable volume pump should be used because ratio of average power demand to peak power demand is low. It requires less energy and reduces system heat input. A relief valve is not needed in the system if a pressure-compensated pump is used.

Rotary rather than linear actuators should be used because they reduce the total linear inches of dynamic seal. They also transmit rotary motion directly without linkage. Linear actuators generate contamination.

A d-c motor should be used because it conserves energy when driving a variable volume pump. It overspeeds at reduced loads and permits using a smaller accumulator.

Wire mesh filters should be used if there is any danger of contamination in the system.

A bellows or diaphragm should be used in the low pressure circuit to compensate for temperature changes.

Elastomer materials should not be used for external seals. Total linear inches of external seals should be kept to a minimum.

Hydraulic fluid must be compatible with seals. If necessary use a special oil to cover the operating temperature range. Sealed unit will not cause an oil stocking problem. No field service will be needed if the unit is contamination free and sealed at the factory. □□□

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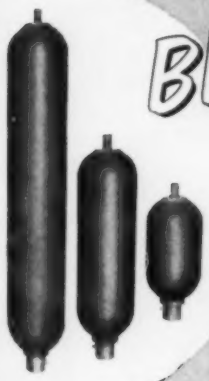
GREER Headquarters for ACCUMULATORS



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OVER 100,000 SOLD, some in continuous use for more than 15 years—proof of superior reliability, safety and dependability in a wide variety of circuit applications. Standard models available in two operating ranges: 0-3000 psi and 0-6000 psi, from 1.5 cu. in. to 2080 cu. in. capacities*.
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A NEW LINE of piston accumulators for standard industrial performance. Features extra built-in safety. Available for 3000 psi operation in nine sizes from 10 cu. in. to 2250 cu. in.capacities.
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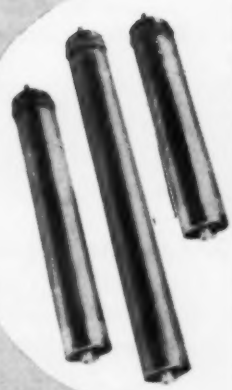

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FOR AIRCRAFT, MISSILE or industrial applications requiring bladder accumulators in special shapes, sizes or operating characteristics. Standard bladder-type transfer-barrier accumulators available in two pressure ranges: 0-3000 psi an 0-6000 psi in a variety of sizes*. Contact your Greer representative with your requirements.

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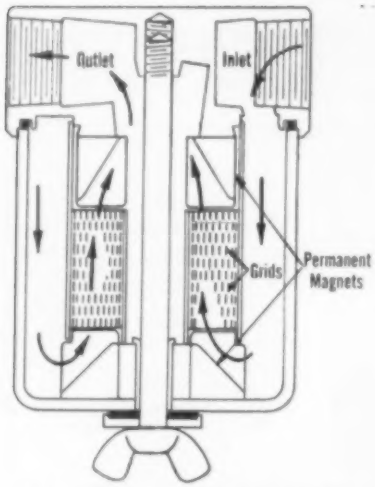


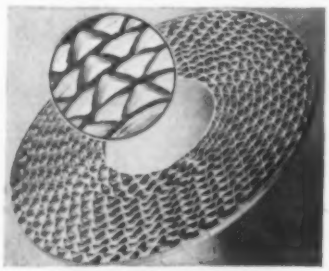
INSIDE STORY of Filter Efficiency

With valves and other components made to extremely close tolerances, hydraulic equipment needs the help of

FERROFILTER®

Magnetic Separators

to keep the circulating fluid free from microscopic ferrous particles.



FERROFILTER GRID

One of a stack of grids, strongly magnetized by two powerful permanent magnets. The grids split the fluid stream into thin elements and force the magnetic particles close to the magnetized grid edges to which the particles are attracted and securely held.

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Circle **59** *on Time-Saver Card*

AVIATION NEWS

from the fluid power field

Ray P. Lambeck has been appointed engineering manager of major programs for the Aero Hydraulics Division of **Vickers Incorporated.** He will supervise

Lambeck

Stauffer

major contracts involving development of new pumping and drive systems for aircraft and missiles. **Gordon E. Stauffer** is now program administrator for the B-70/F-108 pumping system recently awarded to Vickers. He joined the company in 1956 as an aero application engineer for jet engine controls.

Plans for SAE A-6 Fall Meeting

B. R. Teree, chairman of the **SAE Committee A-6,** has announced that the group's next meeting is schedued for Sept. 30-Oct. 2 at the **Sheraton-Jefferson Hotel, St. Louis.**

Groups set for meeting at that time are:

Committee G-3, aircraft and missile fittings and flexible hose assemblies; **Sub-commttee A-6C,** hydraulic pumps, motors and air compressors; **Sub-committee A-6D,** missile fluid power systems, and **Committee A-6,** aircraft and missile hydraulic and pneumatic systems and equipment.

The board of directors of **United Aircraft Products Inc.** has elected **Frank A. Ryan** as vice president of sales, and **Frank J. Coykendall** as treasurer. Ryan was recently manager of contractual engineering, and Coykendall was controller of the company since 1955. **Kenneth O. Parker** was appointed as chief engineer. He was recently assistant chief engineer.

R. B. Brown, Jr. will serve the St. Louis area as a sales engineer for **Hydro-Aire, Inc.** Since 1956, he was supervisor of customer service for Monsanto Chemical Company in that city.

FLUID POWER PRESSURES AND TEMPERATURES IN 1970

Aerospace Industries Association has forecast hydraulic and pneumatic pressure and temperature trends in systems over a ten year period into 1970.

Missile hydraulic pressures—Presently 2000 to 3000 psi with flow rates from 0.4 to 25 gpm, increase will gradually reach about 6000 psi at 2.8 to 50 gpm in 1970.

Missile operating temperatures—Only a slight increase from the present 600 F system to about 750 F is forecast for missile hydraulics.

Aircraft hydraulic pressures—From 1959 pressures of about 3500 psi limits, should reach about 7000 psi. Flow rates should increase to 70 gpm.

Aircraft operating temperatures—By 1970, 1000 F system temperatures will be in operation, in envjronmental temperatures of 1500 F.

Pneumatic system pressures—Trends indicate higher power requirements, with pressures exceeding 8000 psi in 150 to 300 hp systems.

Pneumatic operating temperatures—Gas temperatures will be as high as 2000 F or as low as —300 F in the case of cryogenics.

Circle **55** on Time-Saver Card

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Keep It Simple

with the
ELECTRO-SNAP
One-Way Impulse
PRECISION
LIMIT
SWITCH

Type ES4-KM2 shown

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- Fewer switches needed.
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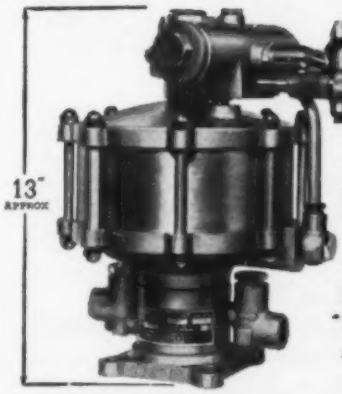
AIRHYDRO POWER UNIT



9 Models with pressure ranges:
62 to 22,500 PSI
Operated by compressed air from
5 to 100 PSI
Weights:
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- Low Unit Cost . . . Easily Installed
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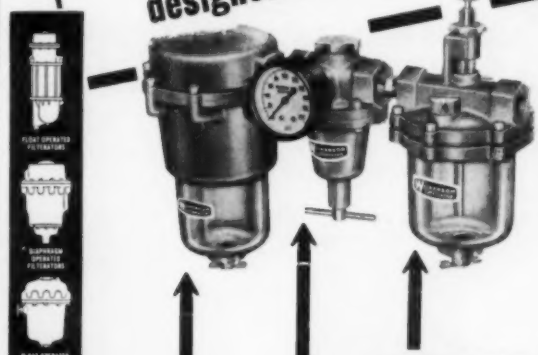
Plan to use . . .

the WILKERSON COMPRESSED AIR COMBINATIONS designed for the OEM



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- Lubricates ¾ to 1200 CFM
- Transparent or metal bowl
- Can be filled without shutting off air
- Tamper Proof adjustment available
- ¼" to 2" P.T. sizes
- 1 and 2 qt., 2 and 5 gal. bowls available

REGULATOR

- Non-chattering, self-relieving
- Equipped with 3 outlet ports
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- Low pressure drop
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- Automatic or manual drain
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- Removes 5 micron particles
- Transparent or metal bowl
- Low pressure drop
- ⅛" to 2" P.T. sizes

Wilkerson's NEW "CONDITIONAIR" units are available in threesomes or twosomes. Attractive OEM discounts.

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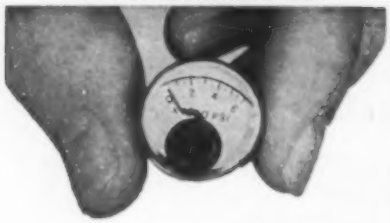

miniaturized *bh** gauges

This ***bourdon helix** gauge, designed specifically for the Hawk missile, measures 0.75 inches across. Threads directly into the pressure vessel, reads 0-5000 psi. Accuracy is ±2% of maximum, and the gauge never requires re-calibration.

When you need special gauges, remember the name GLASSCO.

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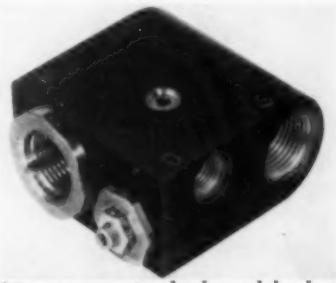
AVIATION COMPONENT DATA

Pressure Regulator . . . for 0 to 3500 psi

Meeting MIL-R-5519, this new regulator has an adjustable speed control restrictor. Flow capacity to



10 gpm on standard models, but can be furnished to 20 gpm. Has a 100,000 cycle minimum life and weight only .78 lbs.—*Kemp Aero Products, West Milford, N.J.*

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Hot Gas Motorpump . . . for missile apu

By modifying a standard axial piston hydraulic motor with heat resistant materials and improved tolerances, this new motorpump

provides auxiliary power from 0.5 hp at 1500 psi to 66 hp at 3000 psi. Speed ratings for the integral units range from 18,200 rpm for the smallest size with 0.095 cu. in./rev. displacement to 8500 rpm for the largest unit with a displacement of 2.35 cu. in./rev. The smallest weighs 2.5 lbs. and is capable of 8.9 hp. Tested to temperatures of 5000 F. *Vickers Inc., Detroit.*

Circle **501** on Time-Saver Card

Filters . . . in new bulletin

Bulletin A-1081 has descriptions of 66 filters with capacities to 43 gpm and pressures to 5000 psi at −65 F to +275 F. These filters can be cleaned and have permanent high dirt capacity.—*Aircraft Porous Media, Inc., Glen Cove, N.Y.*

Circle **502** on Time-Saver Card

Quick Disconnect . . . is self-sealing

For 400 F, 3000 psi service, this coupling can be used for all

aircraft fluids. Action is push-pull and locking is automatic when two halves are coupled. Can be made of Dural for lighter weight.—*Arkwin Industries Inc., Westbury, N.Y.*

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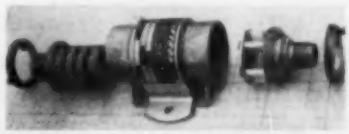
Pressure Switch . . . is leak-proof

This pressure sensing switch uses an all-metal tier tube pressure capsule and a snap action



switch element. Leak-proof and shock-proof, it is stable at high temperatures and operating pressures.—*Meletron Corp., Los Angeles.*

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Continued on page 152

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WITH EXCLUSIVE ROTATING STEM

for MILLIONS of TROUBLE-FREE ACTUATIONS

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Rotoram Valves are available in 3 and 4-way models for ⅛", ¼", ⅜" and ½" pipe sizes. Special Block "V" Packing permits free ram movement, insures long valve life. Port entry from either left or right side. Ask your AIR-MITE Distributor, or write for complete details and illustrated catalog.

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for LESS than a spool valve

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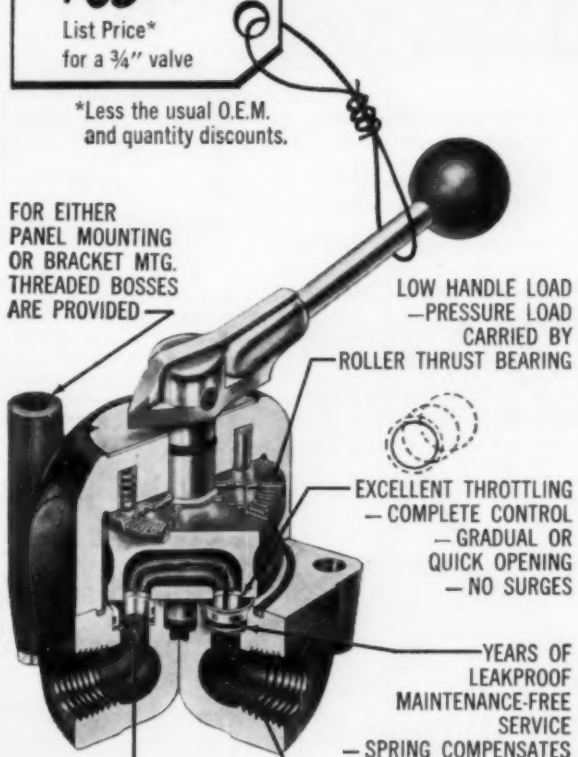
for a ¾" valve

*Less the usual O.E.M. and quantity discounts.



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YEARS OF LEAKPROOF MAINTENANCE-FREE SERVICE — SPRING COMPENSATES FOR NORMAL WEAR

MORE FLOW THRU UNOBSTRUCTED ROUND FLOW PASSAGES

NO EXTERNAL LEAKAGE — PRESSURE IS CONFINED TO FLOW PASSAGES

For complete data on this new valve and for information on all your valve requirements write for Catalog V-59-60

CONTROL VALVE DIVISION

Barksdale valves

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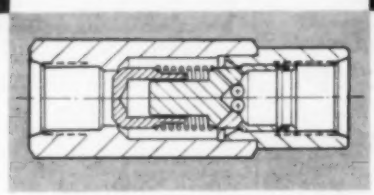
CHECK VALVES
SAE Ports

Sizes In Stock
¼", ⅜", ½", ¾", 1" and 1¼"



- Dependable—Won't Stick Open
- Low Pressure Drop — Full Line Capacity
- For Oil — Up to 5000 psi

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tiny holes assure pressure tight seals
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United's exclusive, patented* self-energized metallic O-rings have tiny holes in the hollow ring wall. The holes are to balance the interior and exterior pressures in order that the ring may respond to variation in deflection of the sealing surfaces with a natural resilience uninhibited by the external pressure.

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PATENTS 2,809,269; *2,837,360

UNITED METALLIC "O" RING CORP.
Division of United Aircraft Products, Inc.

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AVIATION COMPONENT DATA

Solenoid Valve
. . . air and oil

Voltage of one polarity opens valve. Opposite polarity closes valve. Remains in last position if

current is interrupted. At 28 volt d-c, or 110 volt a-c, is available for 2-, 3-, or 4-way operation, air or oil service, to 3000 psi from —65 F to +450 F.—*Dynamic Controls Corp., E. Hartford, Conn.*

Circle **505** on Time-Saver Card

Servoactuators
. . . for high response

This 6-page brochure shows full line of electro-hydraulic servoactuators. Catalog 170 has applications in aircraft, missiles and industrial systems. Cut-away photographs and schematic drawings included, with glossary of servoactuator terms.—*Moog Servocontrols, Inc., East Aurora, N.Y.*

Circle **506** on Time-Saver Card

Diaphragm Pump
. . . assures pure air

Model 373 pump eliminates friction, generated heat, carbon

dust, oily air, and loss of capacity. Rated at 0 to 25 psi at 1 cfm at sea level, it operates at —65 F to 165 F.—*Cornelius Co., Minneapolis.*

Circle **507** on Time-Saver Card

Solenoid
. . . uses internal rectifiers

This 400 cycle a-c solenoid meets MIL-S-4040C, MIL-E-5272B and

MIL-E-5400. Has magnetic efficiency of a d-c solenoid. Ideal for ground support of missile use.—*PSP Engineering Co., Maywood, Calif.*

Circle **508** *on Time-Saver Card*

Pneumatic Fuse
. . . with zero leakage

Simple, accurate safety fuse to prevent blowdown of high pressure gas systems. Pressure drop is less than 10 psi at 200 scfm. Operating pressure is 1600 ±20 psi. Shutoff setting is 250 ±10 scfm. Reopen pressure is 60 psi. Temperature range −65 to +140 F. Weight 13 oz., airborne 9 oz.—*Aerodyne Controls Corp., Huntington Station, N.Y.*

Circle **509** *on Time-Saver Card*

D.C. Motor
. . . is light weight

New D-3910 is ½ hp at 12,500 rpm continuous, 1 hp at 9000 rpm

intermittent duty. 28 volt d-c, explosion proof, weighs only 5.6 lbs. Low radio noise, even brush pressure, high reliability.—*Hoover Electric Co., Columbus, Ohio.*

Circle **510** *on Time-Saver Card*

New Brochure
. . . on fiberglas structures

This 8-page booklet describes fiberglass forms in aircraft and missile systems. Advantages are

Continued on next page

2 NEW! STRATOFLEX HYDRAULIC COUPLINGS

Thanks to non-metallic seals, the new Stratoflex all-purpose couplings guarantee a positive self-sealing unit when connected or disconnected. When the two halves are connected, the valves open automatically to assure maximum flow, with a minimum of pressure drop.

Stratoflex Self-Sealing Couplings are available in three designs: wing nut, hex nut and knurl sleeve, with NPTF Pipe Thread or SAE "O"-Ring Boss Thread, in sizes ranging from ¼" to 1¼".

Stratoflex Quick-Disconnect Couplings are furnished in NPTF Pipe Thread and SAE "O"-Ring Boss Thread, with a size range from ¼" to 1".

For complete information on Stratoflex Hydraulic Couplings, write for Stratoflex Bulletin S-7 immediately.

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Circle **146** *on Time-Saver Card*

PALMETTO® G-T RINGS

For ROD SEALS . . .

For PISTON SEALS . . .

PALMETTO G-T RINGS are resilient packing seals molded from a variety of natural or synthetic rubber compounds into T cross-sections, with two split non-extrusion backup rings on each side. They are used in hydraulic or pneumatic operations as rod or piston seals, in single or double acting systems; for all applications where there is reciprocating motion, with either constant or impulsed pressure; and as static seals, under constant or impulsed pressure.

PALMETTO G-T RINGS effectively seal, without extrusion, at temperatures from minus 70F up to 600F, and at pressures as high as 10,000 p.s.i. They will not wedge into clearances, pinch-off under motion or pressure, or twist in place. Absolutely resistant to destructive deformation, they permit the use (within reasonable limits) of greater clearances between the surfaces being sealed.

PALMETTO G-T RINGS are manufactured to fit standard size bores and rods, and are available in a wide selection of compounds compatible with all types of fluids in a broad temperature range. Special G-T Ring sizes can be made, on order, to meet any design requirement. Several kinds of non-extrusion backup ring materials are also available.

G-T Ring compound 160A complies with Military Specification: MIL-R-003065 Grade SB 715 BE_3Z.

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Greene, Tweed & Co. manufactures a complete line of Palmetto Packings . . . to meet every sealing requirement . . . encompassing every design need:

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AVIATION COMPONENT DATA

high strength to weight ratio, rigidity, structural and electrical integrity and uniformity. Also nonmagnetic, and reproducible to close tolerances at low cost.—*Walter Kidde & Co., Belleville, N.J.*

Circle **511** on *Time-Saver Card*

Filter . . . signals clogging

A dual filter, #52-2290-000, actuates a signal when clogged and puts a second filter in operation. Filters can be cleaned and reused. Rated to 70 microns.—*Aero Supply Mfg. Co., Corry, Pa.*

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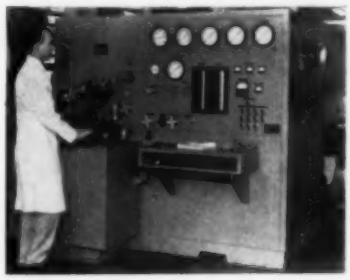
Test Stand . . . checks pumps & drive motors

Model 9508 simulates altitudes to 75,000 feet while testing components. Self-contained stand tests



pumps to 3000 psi and 10 gpm, as well as 15 hp, 400 cps drive motors. Pressure, flow and leakage tests can be performed on this machine.—*George L. Nankervis Co., Detroit.*

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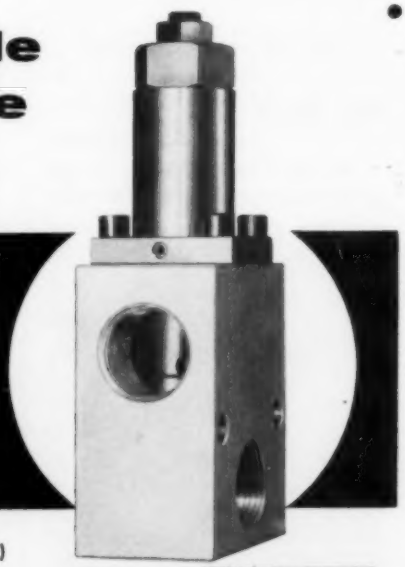
Dependable Relief Valve

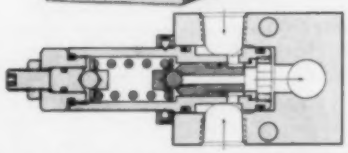
Differential Piston Operation

- Excellent in systems without filters and for hard, rugged service.
- Accurate pressure control
- Fast acting
- Tight seal before cracking
- Economical and sturdy design



• For Oil— ¾ & 1" pipe (NPTF)

Pressure Adjust Ranges	
100 to 800 psi	1,000 to 3,000 psi
250 to 1,500 psi	1,500 to 5,000 psi



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Sheffer pioneered tapered cushions eliminate shock conditions on cushion entrance — permit faster cycling — greater production. BORES up to 30" — STROKES to 26 feet, on application.

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- ALL STEEL CONSTRUCTION
- EASILY REMOVED ROD CARTRIDGE
- BORES 1⅛ thru 12
- 17 MOUNTINGS
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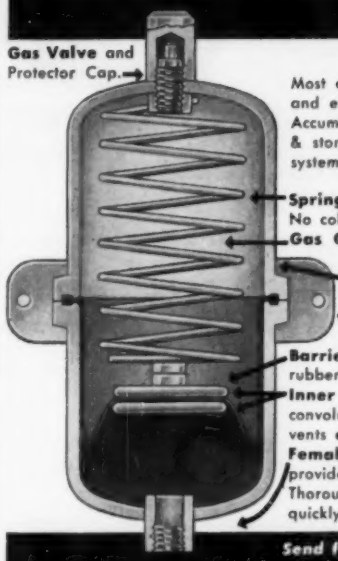
ACCUMULATORS



Gas Valve and Protector Cap.

Most economical and efficient Accumulator for absorbing shock & storage of energy in hydraulic systems. Sizes, 15 to 7500 cu. in.

Spring—Directs bottom of Barrier. No collapsing of Barrier sides.

Gas Chamber — gas precharged to suitable pressure.

Steel Shell—Two sections. Up to 2000 psi pressure.

Clamp Ring—Holds sections firmly. Easily removed.

Barrier—"Hat Shape." Synthetic rubber. "O" ring seals shell sections.

Inner and Outer Plates—Starts convolutions of barrier and prevents extrusion through liquid port.

Female Pipe Threads — Can be provided to meet specifications.

Thorough cleaning maintenance is quickly performed when necessary.

Send for specifications and descriptive literature at once.

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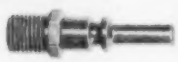
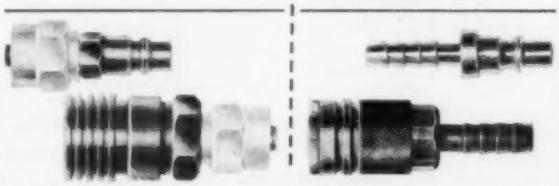
interchange couplers for every industrial application





Couplers and nipples with many types and sizes of inlet ends available that will interchange with competitive makes. There is a *TRU-FLATE "type"* or a *TRU-FLATE "interchange" coupler* to meet every industrial need.

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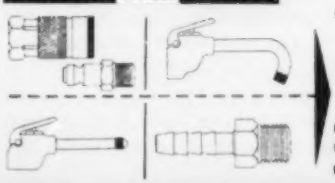

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lowest temperature rise and power consumption

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stainless steel plunger design / silver ac shading coil

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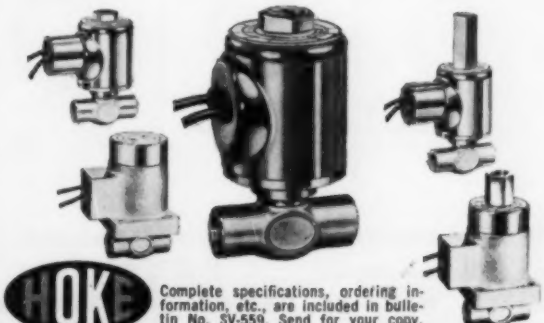
smallest size/packless construction/operates any position



HOKE

Complete specifications, ordering information, etc., are included in bulletin No. SV-559. Send for your copy.

Fluid Control Specialists

HOKE INCORPORATED, 87 PIERMONT RD., CRESSKILL, N. J.

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YOU NAME THE APPLICATION... ASHCROFT GAUGES MEET *EVERY* REQUIREMENT

For more than 100 years the name Ashcroft has stood for the most advanced pressure gauge research, design and engineering. By anticipating the constantly changing and expanding needs of all industrial users, we have combined in Ashcroft Gauges the highest degree of accuracy and long-life service for every type of installation. You can select dial sizes ranging from 2" through 24" . . . pressures from 30" vacuum or a few ounces up to 100,000 psi . . . materials that meet all service demands.

There are three classes of Ashcroft Gauges. Each class has functional characteristics suited to the applications for which it is recommended.

DURAGAUGES. The finest pressure gauges built. Highest accuracy and durability make them ideal for the toughest services. They save many times their original cost in replacements and repairs.

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Among the many Ashcroft Gauges are Maxisafe®, pneumatic receiver, recording, chemical and special application gauges, plus a variety of gauge testers. Get all the facts. Learn why Ashcroft Gauges are the best investment you can make. *Write for Catalog 300B.*

Quality Gauge No. 1010 for general applications.

Quality Gauge No. 1056 for hydraulic presses.

Quality Gauge No. 1006 for small equipment.

Special Purpose Gauge No. 1009. Heavy-geared.

Vibration-Resistant Gauge No. 1122. Heavy-duty gearless.

Duplex Gauge No. 1038 A. Indicates two pressures on dial.

ASHCROFT PRESSURE GAUGES

A product of

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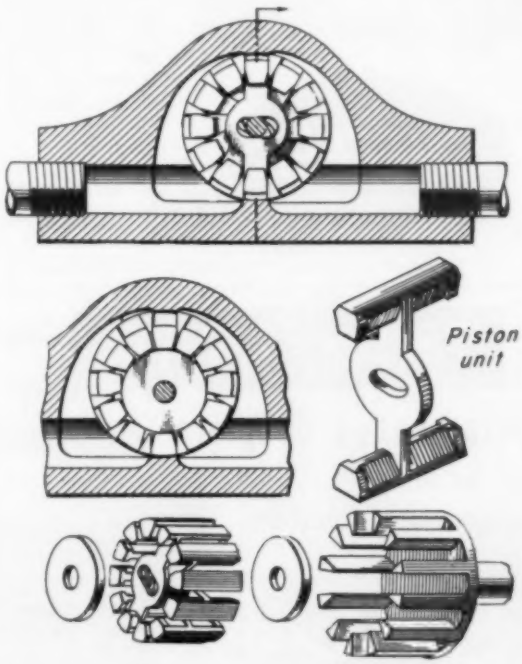
FLUID POWER PATENTS

VARIABLE DELIVERY PUMP

The pump is designed for speeds to 4000 rpm. It is suitable for direct drive in aircraft and ordnance servo systems. It has an output adjustment lever which operates with very little force and holds a set position with no force.

The rotor (driving member), is similar to the driving gear in an internal gear pump. As it rotates, it drives the piston assembly with it. Pump output is changed by varying the piston displacement. Output



is zero when the rotor and piston assembly are concentric. Flow increases as the excentricity of piston assembly and rotor increases.

The piston assembly is made in six units. Each unit has a rectangular piston at each end of a connecting web. Six units are assembled to form a complete piston. They are spaced at equal angles to fit into the cavities in the rotor. A concentric cam mounts at each end of the assembly. The cams slide under the pistons to keep the entire assembly concentric.

The piston assembly rotates around a shaft that extends through the cams. Pump volume is changed by moving the shaft from side to side. A crankshaft extending through the pump cover plate moves the shaft.

U. S. Patent 2,867,175 by Juston W. West, United States Navy.

Continued on page 162

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GRESEN HYDRAULICS

DOUBLE SELECTOR VALVE

FEATURES: Cast iron body—chrome plated, pressure balanced spool—Easy to mount —Three optional handle positions.

SPECIFICATIONS: Capacity—24GPM @15 ft/sec.
Pressure range—0 to 1500 PSI
All openings—¾" NPT
Shipping weight—12 lbs.

WRITE FOR LITERATURE

GRESEN *Mfg. Co.*
405 35th Ave. N.E., Minneapolis 18, Minn.

Saves hours in piping installations

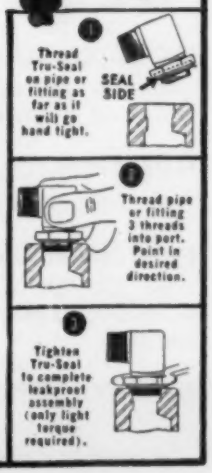
PAT. PENDING

Eliminates leaks in oil, air, water, vacuum, chemical lines

Tru-Seal saves hours in assembling piping installations because it enables you to run your pipe lines in any direction you wish, quickly and easily—without having to recut and re-thread piping sections. Wherever used on air, oil, water, steam, vacuum or chemical lines, it seals perfectly at —100° F. to plus 500° F.—*without the use of pipe dope.* Its installation requires only light tightening torque, thus eliminating over-tightening damage to valves, pumps, compressors, and other fittings.

For further information write

TRU-SEAL DIVISION
FLICK-REEDY CORPORATION
7N017 York Rd., Bensenville, Ill.
"Niller Fluid Power" is also a Div. of Flick-Reedy Corp.


1
Thread Tru-Seal on pipe or fitting as far as it will go hand tight.
SEAL SIDE
2
Thread pipe or fitting 3 threads into port. Point in desired direction.
3
Tighten Tru-Seal to complete leakproof assembly (only light torque required).

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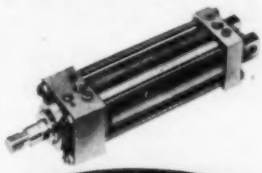
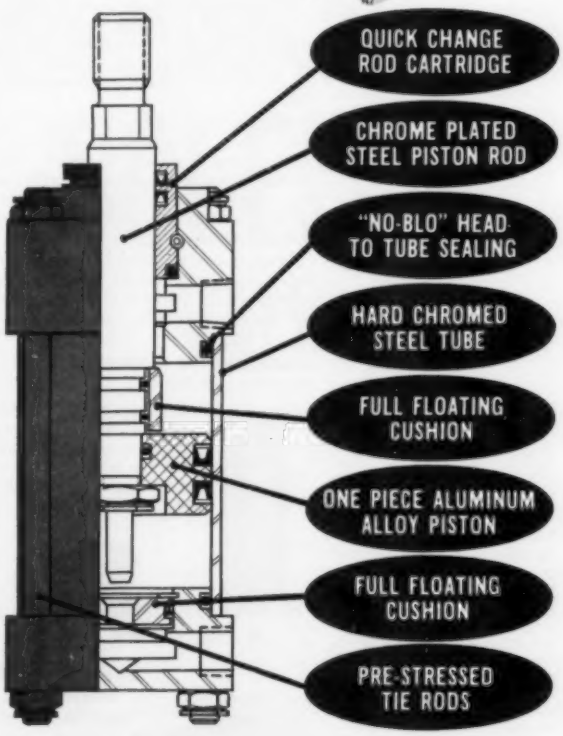
YOU, WHEN **YOU** DISCOVER THE DESIGN ADVANTAGES OF . . . .

LINDBERG

SQUAREHEAD CYLINDERS

DESIGN IN LINDBERG
AND . . . ADD ALL THESE
FEATURES!
and many more besides!




QUICK CHANGE ROD CARTRIDGE
CHROME PLATED STEEL PISTON ROD
"NO-BLO" HEAD TO TUBE SEALING
HARD CHROMED STEEL TUBE
FULL FLOATING CUSHION
ONE PIECE ALUMINUM ALLOY PISTON
FULL FLOATING CUSHION
PRE-STRESSED TIE RODS

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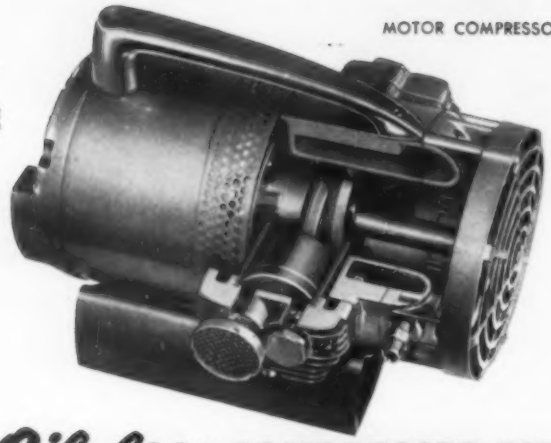
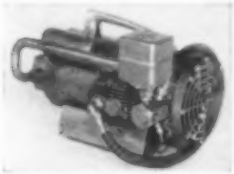


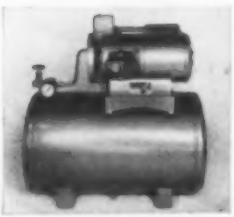
MOTOR COMPRESSOR

Oil-less COMPRESSED AIR

FROM YOUR CHOICE OF 58 MODELS

TANKLESS MOTOR COMPRESSORS
For use where existing air tanks or pipe lines provide compressed air storage; 35 and 75 lb. single stage, 175 lb. two stage, ¼ to ¾ HP, 60-cycle motors, displacement to 6.57 CFM at 1725 RPM.





10 GAL. AIR TANK MOTOR COMPRESSOR OUTFITS
Available in wide range of capacities; portable when cart-mounted. 35, 75 and 135 lb. outfits mounted on Non-Code Air Storage Tank tested to 150 lbs.; 75 and 175 lb. outfits available with ASME Code built tank tested to 350 lbs.

"PIGGY-BACK" COMPRESSOR TANK
Compact, portable 2-gallon tank assembly, easily attached to any B&G 75 lb. or 175 lb. Motor Compressor, or Tankless Outfit.

You'll find the compressor you need in the B&G line! Choose from 58 models—lightweight portables, bare compressors, tankless motor compressor outfits, air tank motor compressor outfits; from ¼ to 1½ HP capacities, pressures to 190 psi.

There's never any oil-spoiled work with B&G Compressors—they *never need oiling.* Powered by B&G built motors, they are constructed with carbon graphite piston rings and skirts which need no lubrication; bearings are grease-packed and sealed for life.

Numerous additional design and construction features assure long-lived, dependable delivery of cleaner, cooler, drier air and smooth operation.

30 GALLON AIR TANK MOTOR COMPRESSOR OUTFITS

75 and 175 lb. outfits mounted on 30 gallon horizontal or vertical air tank built to ASME Code requirements and tested to 400 lbs.

GASOLINE ENGINE-DRIVEN COMPRESSOR OUTFITS
Light weight compact, cart-mounted.

For complete information on B&G Oil-less Compressors and Vacuum Pumps, send for Catalog GO-1156.

Oil-less AIR COMPRESSORS

BELL & GOSSETT COMPANY

Dept. FW-66, Morton Grove, Illinois

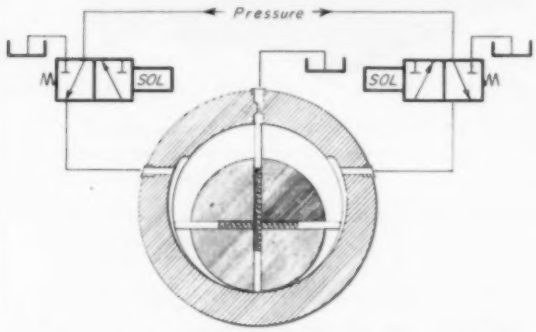
Circle **23** *on Time-Saver Card*

HYDRAULIC POSITIONER

The unit is similar to a vane-type fluid motor. However, its rotation can be stopped at any point for accurate positioning.

• **Operation**—The schematic drawing shows the rotor in its stopped position. To rotate it, the right hand solenoid valve is energized. Pump flow enters the positioner through the left port and returns to the reservoir through the right port. The rotor turns clockwise.

Rotation continues until the solenoid is deenergized and pressure is applied to both ports. Fluid escaping



through the orifice on top of the positioner moves the nearest vane to a position directly under the orifice. Since the vanes are narrower than the orifice, fluid escapes equally from both sides *detenting* the vane. Any attempt to move the vane away from the orifice unbalances the pressure and returns the vane to its position under the orifice.

Energizing the left solenoid rotates the positioner counter-clockwise.

U. S. Patent No. 2,873,725 by Paul A. Gilovich, assigned to International Business Machines Corp., New York.

Other Patents Issued

HIGH PRESSURE ROTARY PUMP

No. 2,878,757 by John Marco, Earlville, Md.

CLOSED CENTER VALVE WITH ZERO LEAKAGE

No. 2,882,867 by William B. Thompson, assigned to General Motors Corp., Detroit, Mich.

FLUID-OPERATED VALVE

No. 2,882,930 by Luther E. Lee, Takoma Park, Md.

MANIFOLD MOUNTED VALVE

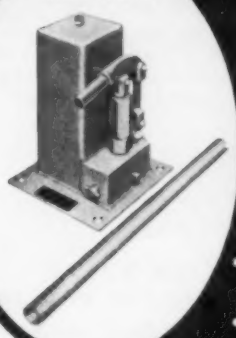
No. 2,879,788 by Donald E. Beckett and William N. Beckett, assigned to Beckett-Harcum Co., Wilmington, Ohio.

BALANCED CONTROL VALVE

No. 2,876,796 by Stuart D. Pool and Edward M. Melin, assigned to International Harvester Co.

Circle **125** on Time-Saver Card

CATALOG NO. 160



Hand Hydraulic Pumps

- Single and Double Designs to 20,000 psi
- With or Without Reservoir

160 cubic inch reservoir with 8"x 8" base plate and 18" long handle.

Available with optional size pistons ⅜", ½", ¾", 1" and 1½".

We specialize in the manufacture of hand pump units which operate in temperatures from −65° F. to +160° F. and with any capacity reservoirs required. Pumps can be furnished on special order with custom seals to handle various aircraft types of fuels such as Pydraul, Skydrol, Oronite, etc.

The single pump with ½", ¾", 1" or 1½" piston is now available in stainless steel.

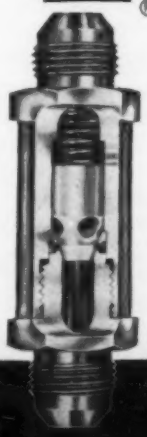
for additional information write:

WILLIAM S. PINE

hydraulic hand pumps for 1001 uses

1635 East 22nd St., Los Angeles 11, Calif.

Circle **89** on Time-Saver Card



Complete line of VALVES

- Flexible Seal Seat* VALVES
- CHECK VALVES
- RELIEF VALVES
- SHUTTLE VALVES
- CARTRIDGE VALVE INSERTS

Specify Kep-O-seal! — leakproof construction designed for efficient fluid flow and reasonable cost. This name is your assurance of quality; backed by two generations of specialized service to industry.

*PAT. APP'D. FOR.

Write for Complete Detailed Information.

KEPNER PRODUCTS COMPANY

7321 West 59th Street Summit, Illinois

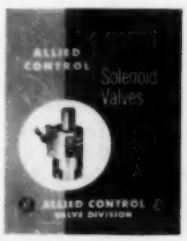
MINIATURE SOLENOID VALVES

- **Small Size: (1½"x2¾")**
- **Large Capacity**
- **Packless—only 2 moving parts**

Available in 2- and 3-way normally open and closed types, this new line of solenoid valves has a pressure range from 0 to 400 psi. Bodies can be supplied in stainless steel, brass and aluminum.

NEW FEATURES:

- Operating temperature of +110° C to −65° C—higher temperature requirements can be supplied on special order.
- Many modifications are possible including side, bottom and top metering (3-way and 2-way normally open).
- Several models are U. L. Approved.
- New Type "S" valve designed for completely noiseless operation.



FOR MORE INFORMATION WRITE FOR BULLETIN V.

ALLIED CONTROL VALVE DIVISION

ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, N. Y.

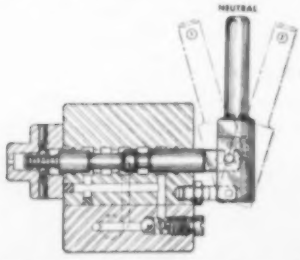
AL-197

Circle **10** on Time-Saver Card

new 10,000 psi FOUR-WAY VALVES

effortless operation for applications up to 10,000 psi

Have valving problems on hydraulic applications calling for high pressures up to 10,000 psi? This new GREENLEE Four-Way Valve may be your answer. Simple, trouble-free spool-type valve . . . completely balanced to provide effortless operation at any pressure in any position. It operates with the same ease at 10,000 psi as at 0 psi. Panel mounted for universal adaptability. Subplate available. Precision-made, precision-tested. (Max. leakage 4 cu. in. per minute at 10,000 psi.) Write today for illustrated data sheet.



GREENLEE Four-Way Valve is available in two models: No. 1717 (above) with detent-positioned control lever . . . No. 1704 with spring-centered control lever.

THE GREENLEE LINE ALSO INCLUDES A WIDE SELECTION OF HAND AND POWER-OPERATED HYDRAULIC PUMPS

GREENLEE

GREENLEE TOOL CO.

1776 Columbia Ave., Rockford, Illinois

Circle **65** on Time-Saver Card

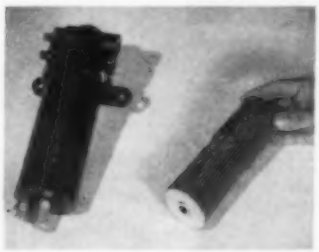
NEW PRODUCTS

Continued from page 72

AIR LINE FILTER
. . . removes water, dirt, oil

Designation: Micropleat (571000)

Features: For precision air gage applications where positive removal of dirt, water, and oil requirement for functioning. Filter



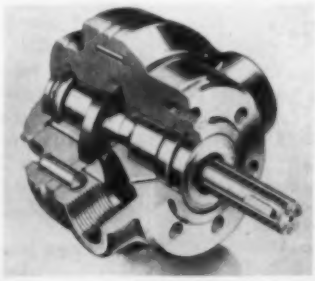
assembly has aluminum filter that houses inlet and outlet ports, chemically-coated aluminum bowl with drain cock, and element. Four standard ¼" pipe threaded ports (2 inlet, 2 outlet) allow versatile mounting of assembly.

Specifications: Filter housing withstands pressures to 125 psi, rated flow is 15 scfm at 100 psi line pressure. Rated at 10 microns. Almost 10" long. Filter head has mounting holes on 4⅛" centers.

Bendix Filter Division
Bendix Aviation Corp.
Madison Heights, Mich.
Circle **316** *on Time-Saver Card*

PUMP LINE
. . . for use with F-R fluids

Designation: Series 800 Gerotor



Features: Dimensionally interchangeable with regular oil-hydraulic units of like capacities, and most competitive pumps. For applications where fire hazards make use of hydraulic oils dangerous—die casting, welding, forging.

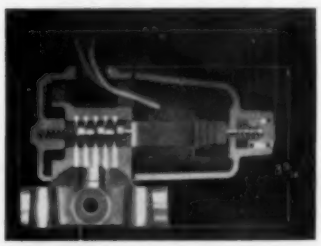
Specifications: In 3, 5, 8, and 12 gpm sizes in QDH-830 single pumps; 20, 30, and 40 gpm sizes in OG-860 single pumps, and any combination of 3, 5, 8, or 12 gpm in QGH-H830 double pumps.

Double A Products Co.
Brown & Sharpe Mfg. Co.
Manchester, Mich.
Circle **317** *on Time-Saver Card*

SMALL AIR VALVES
. . . have high cycle speeds

Designation: SA Junior Series

Features: Applicable to automatic assembly machines and packaging operations. Offer design features of larger series. Low cost. Operate cylinders having up to 4" bores where high piston speeds are not a factor. Basically are two valves—single solenoid spring return 4-way, and double solenoid momentary contact 4-way. Provides small physical size, relatively low air-carrying capacity, high cycle speeds. Solenoids easily replaced.



Specifications: For vacuum service or pressures to 300 psi. Speeds to 450 operations per minute continuous duty; 600 for intermittent duty. Response averages about 11 millsecs. on 60-cycle AC current. Inrush current is .85 amperes and holding current is .23 amperes on 115 v., 60-cycle current. Standard voltage are 115, 230 v., 60 cycles. Others by special order.

Numatics, Inc.
Highland, Mich.
Circle **318** *on Time-Saver Card*

TIME DELAY RELAY
. . . offers split-second recycling

Features: Reset time less than .020 sec. Easily adjusted. Modern design of timing head assembly provides internal recirculation of air for consistent timing. Larger contacts provide greater dissipation of heat. New contact material increases

Continued on page 166

Circle **106** on Time-Saver Card

Modernair

VIH (VALVE-IN-HEAD)
CYLINDERS

Save Space, Weight & Piping

NO SEPARATE VALVES TO MOUNT OR PIPE . . . Modernair's VIH cylinders have directional and exhaust speed control valves built in!

FEATURES:
*COMPACT CYLINDER-VALVE "PACKAGE" includes built-in directional control, exhaust speed control valves.
*SOLENOID, BUTTON BLEEDER or PILOT PRESSURE valve operation.
*INTERCHANGEABLE MOUNTINGS.

BRIEF SPECIFICATIONS:
DIAMETERS: 1½", 2", 3" ROD SIZES: ½", ⅝", ¾"
MIN. OPERATING PRESSURE: 20 p.s.i.
MAX. OPERATING PRESSURE: 150 p.s.i. (solenoid)
200 p.s.i. (bleeder or pilot pres.)

Write for catalog, prices today—or phone your local MODERNAIR distributor (listed on your phone book Yellow Pages).

Modernair CORPORATION

Dept. B-9 400 PREDA STREET, SAN LEANDRO, CALIF.
5007 Brookpark Rd., Cleveland 34, Ohio 38

Circle **78** on Time-Saver Card

THE COMPLETE PACKING UNIT
for Hydraulic or Pneumatic rods and cylinders

MON-O-PAK®
CARTRIDGE

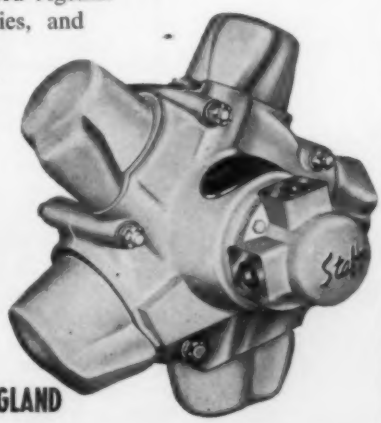
- Easily and quickly installed.
- No adjusting necessary.
- Equipped with Anti-Backlash rings.
- Includes Seal-Guard® rod wiper.
- Low friction coefficient.
- Shock and burst proof.
- Reduces initial machining cost.
- Gives longer service life.
- Cuts machine down-time.
- Easily removed for replacement.

Write for catalog and prices.

HYDRAULIC ACCESSORIES CO.
24301 Hoover Road, Warren Mich.

TECHNICAL SALES AGENTS
wanted for U.S.A.

Technical Sales Agents are required throughout the United States for well-known British manufacturers of Hydraulic Motors (as illustrated). Many pending enquiries from United States manufacturers will be passed to appointed Agents.
Exclusive territories, and only Agents with appropriate technical representation should apply to



CHAMBERLAIN INDUSTRIES LTD.
STAFFA WORKS,
ARGALL AVE.
LEYTON,
LONDON, E.10, ENGLAND

STAFFA

HIGH TORQUE VARIABLE SPEED (1-100 r.p.m.) HYDRAULIC MOTOR

Three Models now in production:
Mark III—5 cylinder 3,500 lbs. ft. at 1,500 p.s.i. (Speed 1-100 R.P.M.) **Mark IV**—5 cylinder 4,500 lbs. ft. at 2,000 p.s.i. (Speed 1-100 R.P.M.) **Mark V**—7 cylinder 6,600 lbs. ft. at 2,000 p.s.i. (Speed 1-75 R.P.M.) Overall efficiency 90% to 95%.
Ideal drive for conveyors, rolling mills, cranes, tractors, drills and most mechanical handling applications.

Ask for details of hydraulic cylinders, valves, pumps and motors.

CHAMBERLAIN INDUSTRIES LTD

Staffa Works, Staffa Rd., Leyton, London, E.10, England.
Leytonstone 3678
(*Member of the Chamberlain Group of Companies*)

Circle **32** on Time-Saver Card

NEW PRODUCTS

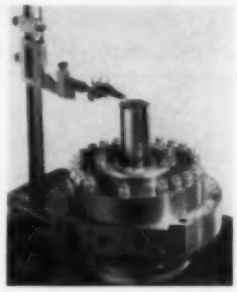
life span. Both NO and NC contacts are now flexible, providing wiping action which assures positive contact continuity.

Specifications: Dials marked over range of .080 sec. to 15 min. in five timing ranges. Temperature range from −65 to +165 F. Maximum AC pick-up voltage is 85% of nominal operating voltage; DC is 80%. AC drop-out voltage 50% of nominal; DC 15%.

AGA Division
Elastic Stop Nut Corp.
Elizabeth, N. J.
Circle **319** *on Time-Saver Card*

ROTARY ACTUATORS
. . . in three models

Designations: Models 30-87-120, 30-100-90S, 30-190-120



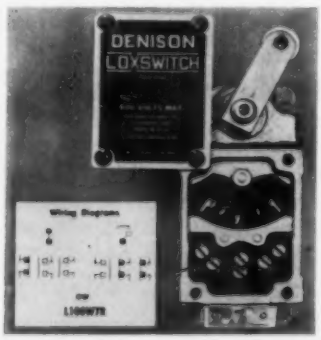
Features: For critical ground applications. Have high torque/inertia ratio. Provide power for rotary vibration testing, angular load testing, and high-powered angular positioning.

Specifications: For three models, stall torque is from 8700-19,000 in-lb. at 3000 psi. Internal leakage from .20-.30 gpm. Weights from 36-80 lbs. All frequency responses are 0-200 cps. Model 30-100-90S has 15° internal snubbing, others none.

Vard, Inc.
A Subsidiary of Royal Industries, Inc.
Pasadena, Calif.
Circle **320** *on Time-Saver Card*

LIMIT SWITCH
. . . for unusual applications

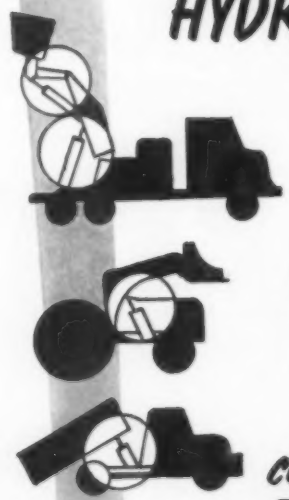
Designations: L1OOWTR, L1OO-WTL



Features: This three-circuit switch permits many circuit arrangements, giving savings in switches, wiring, installation cost. When enclosed in housing with standard model, switches readily usable on many existing mountings.

Specifications: Clockwise or counter-clockwise operation, both with two NO and one NC circuit. Both models reversible to give one NO and two NC circuits and have ¾" conduit opening to allow ample room for wires. All have 70° safety overtravel in both directions, fully

ON THE JOB...
with CROSS
HYDRAULIC CYLINDERS



Stay "on the job" with dependable, rugged Cross Hydraulic Cylinders. Like Cross customers everywhere, you too, will appreciate the fast, courteous, dependable service you get from Cross. Phone for speedy delivery on any quantity...quality-built to your specifications. Contact Cross Engineering Department, today!

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- DEPENDABLE
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CUSTOM DESIGNED CYLINDERS FOR EVERY APPLICATION

Try CROSS CYLINDERS in your operation... low cost, dependable, and trouble free.

Lowest-Priced Engineered Quality Cylinders Available..

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HYDRAULIC CYLINDERS MFG CO CROSS

CROSS MANUFACTURING CO.
LEWIS KANSAS – PHONE EA 4-5525

WRITE • WIRE • PHONE...TODAY!!

Circle **42** *on Time-Saver Card*

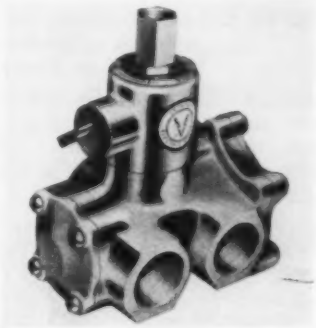
isolated circuits, heavy solid silver contacts, and are oil tight, NEMA 12.

R. B. Denison Mfg Co.
Cleveland, Ohio
Circle **321** *on Time-Saver Card*

3-WAY SOLENOID VALVES . . . for high flow

Designation: L3 Series

Features: Controls hydraulic oils, other liquids. Compact, light, mounts in any position directly to the line, built to UL standards. Synthetic inserts, seals provide



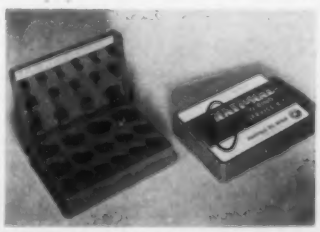
bubbletight operation. Coated nylon diaphragm assembly assures long life.

Specifications: Pressure differential of 5-150 psi. In ⅜, ½, and ¾" sizes. NO, NC. Bodies of naval forged brass, internal parts of stainless steel and brass.

Skinner Electric Valve Division
New Britain, Conn.
Circle **322** *on Time-Saver Card*

OIL SEAL KIT . . . simplifies O-ring servicing

Features: Compact, shatter-proof plastic case affords dirtfree pro-



tection. Lid design ups storage space by using molded-in spindles for smaller rings. O-ring numbers clearly embossed with size specifi-

Continued on next page

ROPER **HAS KNOW-HOW AND FACILITIES TO GIVE YOU PERFORMANCE AND COST ADVANTAGES...**

Here, at Roper, we sometimes get the comment: "We need a pump of a custom nature, but it appears we can produce it ourselves."

While we do not quarrel with the theory that a do-it-yourself project *may lead* to results wanted, we often question if such results are commensurate with the price paid in time, effort and capital expenditure. We prefer to think that our plant and our staff can produce custom pumps that *will* fill the bill — and at *appreciable savings* to the customer. We feel this way because Roper has specialized in manufacturing pumps for over a century, and has the up-to-date know-how and facilities to cope with any pumping problem.

If you are currently working on either high or low pressure systems . . . if size and weight are determining factors . . . if time and money are of great importance, then direct your inquiry to Roper for valuable assistance and dependable pumps. May we roll up our sleeves to help you?

ROPER
ROTARY PUMPS

ROPER HYDRAULICS, INC.
709 Blackhawk Park Avenue, Rockford, Illinois

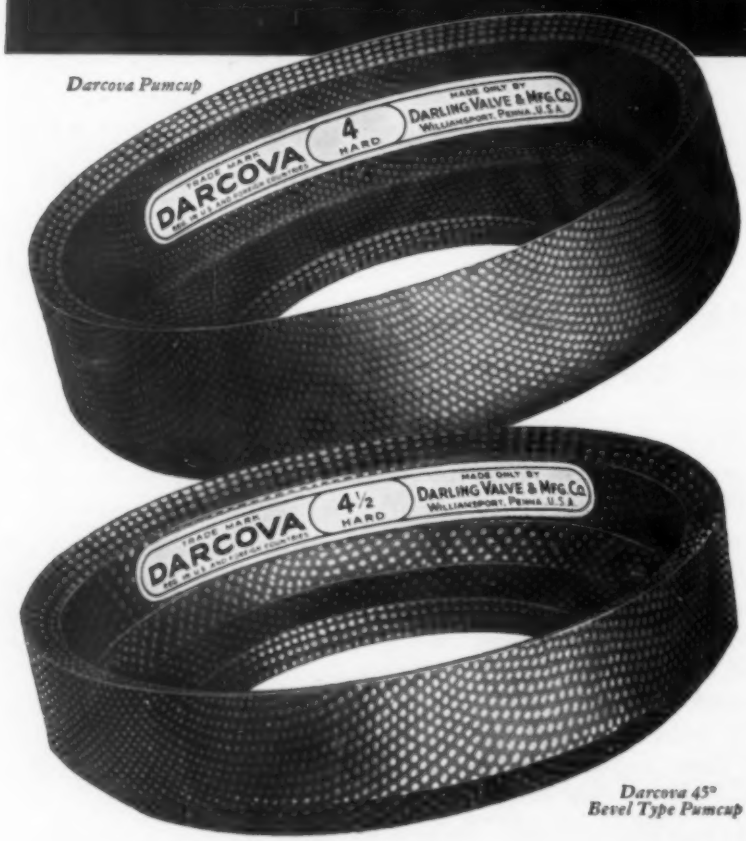
Circle **136** *on Time-Saver Card*

DARCOVA PUMCUPS

now available with

100% NYLON COMPOSITION

for HYDRAULIC CONTROLS, AIR CYLINDERS, RECIPROCATING PUMPS



Darcova Pumcup

Darcova 45° Bevel Type Pumcup

DARLING Pumcups—long noted for unequalled efficiency and life in all kinds of cylinders—are now greatly exceeding their own performance records! The new 100% Nylon Composition, available *only* in Darcova Pumcups, does it!

Nylon Pumcups are made in sizes, types and textures exactly right for your particular equipment—ready *now* to give you unprecedented piston packing performance!

Write for helpful data Bulletin No. 5503.

DARLING VALVE & MANUFACTURING CO.

Williamsport 15, Pa.

DARCOVA THE ORIGINAL COMPOSITION CUP

TRADE MARK PUMCUPS

Circle **44** *on Time-Saver Card*

NEW PRODUCTS

cation. Gage molded in base for quick check on ring diameter.

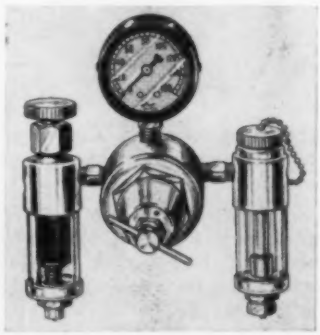
Specifications: Contains most-wanted sizes, about 305 pieces. Case is 9¼x6⅝x1⅝".

Federal-Mogul Service
Division of Federal-Mogul-Bower Bearings, Inc.
Detroit, Mich.

Circle **323** *on Time-Saver Card*

FILTER-OILER-REGULATOR . . . handles capacities to 7 cfm

Features: This air line oiler functions automatically, furnishing oil mist proportional to air used. Oil delivery can be regulated on bottom of oiler. Compact design has



adjusting screw of ample diameter and easily-removed valve seat. Flow unrestricted with minimum pressure drop.

Specifications: Equipped with ⅛" FPT. Pressure from 0-160 psi. For air pressures to 150 psi, maximum temperature of 150 F.

Oil-Rite Corporation
Manitowoc, Wis.

Circle **324** *on Time-Saver Card*

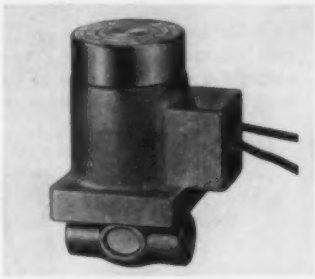
SOLENOID VALVES . . . have watertight housings

Designations: Series 90 and 95

Features: Housings watertight and explosion proof. Have AC shading coils of silver, fully rotatable coil housings for electrical connections. Will operate in any mounted position. Smallest solenoid valves available. Small-ported. Quiet operation.

Specifications: Brass or stainless steel bodies. Coil housings of high-

strength cast iron, cadmium plated. A ½" threaded conduit hub as part of housing. NO, NC, or Universal



operation. Orifice range of pipe connections from 1/32-⅛" Series 90; 2-way types; 1/32-1/16" Series 95, 3-way types.

Hoke, Incorporated
Cresskill, N. J.

Circle **325** *on Time-Saver Card*

STACK VALVE
. . . is "add-on" type

Features: For use where hydraulic valve requirements might increase. Two or three different types of valves can be bolted to standard unit valve when required. Unit is

Continued on next page

Circle **27** *on Time-Saver Card*

A HANDFUL OF POWER

DOWTY Pressure Balanced HYDRAULIC GEAR PUMPS

Pressures to 2500 PSI • Outputs from 1/2-60 GPM

Shown here is our Model GP2-85 which will deliver 18 GPM at pressures to 2000 PSI. Volumetric efficiency exceeds 95% throughout the operating range. Fully pressurized lubrication independent of discharge pressure. 14 other sizes available.

Berry Hydraulics
A Division of Oliver Tyrone Corp.

MAIL FOR COMPLETE DATA

Berry Hydraulics
2227 Oliver Building
Pittsburgh 22, Pa.

Name_____
Company_____
Address_____

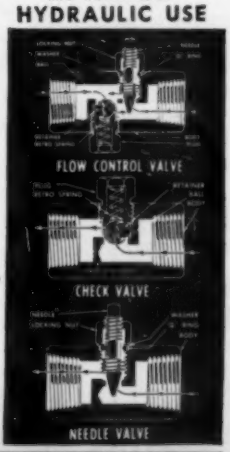
Get Easier, More Accurate Cylinder Speed Control

2,000 (brass or aluminum) and 5,000 (steel) p.s.i.

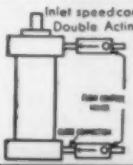
with **Pneu-Trol®** VALVES IN AIR OR HYDRAULIC USE

Pneu-Trol Valves combine in a short, compact body, a tapered fine thread needle for extremely accurate air or oil flow control and a floating retro ball check, which permits full flow in the opposite direction. Retro ball floats in most sensitive position to seat, requiring only a slight differential pressure to fully open or close it. Check Valve and Needle Valve incorporate single function features of Flow Control Valve. All valves available in 5 female pipe sizes — ⅛" to ¾". Valve bodies are made from brass, aluminum, steel or stainless steel. Attractive Prices — Immediate Delivery.

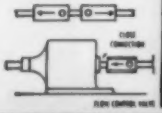
Write for Illustrated Circular and Price List.



Inlet speed control for Double Acting Cylinder.



Single Acting Cylinder Speed Control.



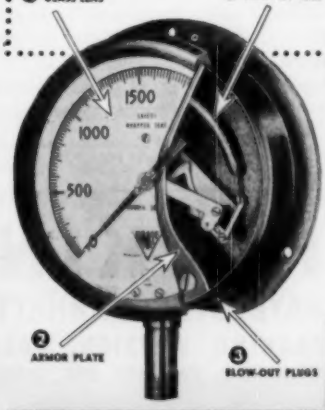
AUTO-PONENTS INC 2919 GRANT STREET BELLWOOD (Chicago Suburb) ILLINOIS

Circle **127** *on Time-Saver Card*

KUNKLE GAUGES
for Process Applications

AVAILABLE IN MANY TYPES and SIZES
15 p.s.i., or 30" of vacuum, to 20,000 p.s.i.

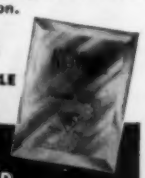
...and the NEW KUNKLE SAFETY CASE GAUGES



...safer because:

1. Rifle-bored steel Bourdon tube is safety wrapped.
2. Armor plate behind dial.
3. Blowout plugs located for downward relief.
4. Shatterproof dial lens.
5. Solid back gives full area protection.

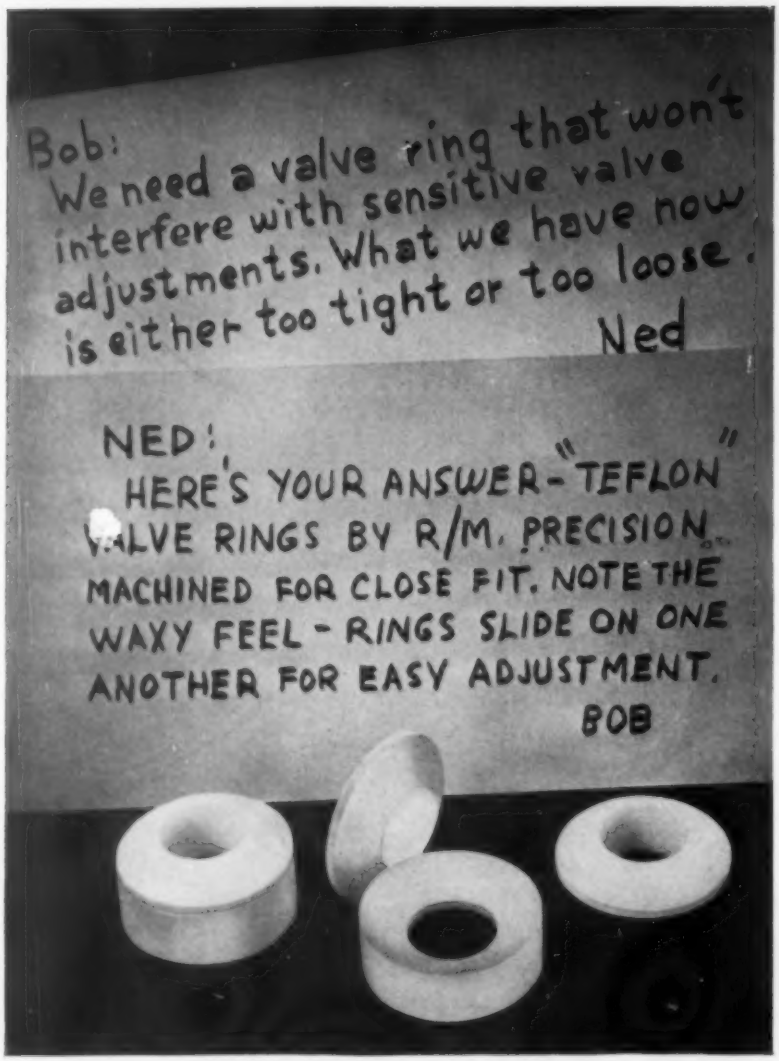
by the MAKERS of DEPENDABLE KUNKLE VALVES



WRITE FOR CATALOG & ENGINEERING DATA

KUNKLE VALVE CO. • FT. WAYNE, IND.

Circle **92** *on Time-Saver Card*


Bob:
We need a valve ring that won't interfere with sensitive valve adjustments. What we have now is either too tight or too loose.
Ned
NED!
HERE'S YOUR ANSWER - "TEFLON" VALVE RINGS BY R/M. PRECISION MACHINED FOR CLOSE FIT. NOTE THE WAXY FEEL - RINGS SLIDE ON ONE ANOTHER FOR EASY ADJUSTMENT.
BOB

"Teflon"* Valve Stem Packings are just what you need when you are making sensitive adjustments on slow moving rotary and reciprocating equipment. The precision machined rings slip on each other and exert pressure against the valve stem or rod. Because it does not react to any known chemical and has no known solvent, "Teflon" is ideal where corrosion is a problem. It has excellent nonadhesive properties—an added benefit if you are handling viscous fluids. "Teflon" Valve Stem Packings are supplied in wedge and angular type and as solid unit rings.

R/M also manufactures a complete range of homogeneous and reinforced valve stem packings engineered to meet many other requirements: high temperatures, high pressures, high speeds, temperature extremes, etc.

Feel free to call on the experienced R/M packing engineers for details and service, whatever your packing needs.

R/M MAKES A COMPLETE LINE OF MECHANICAL PACKINGS—including Vee-Flex®, Vee-Square®, Universal Plastic, and "versi-pak"®; GASKET MATERIALS; and "TEFLON" PRODUCTS. SEE YOUR R/M DISTRIBUTOR.

*A Du Pont trademark

R/M **PACKINGS**

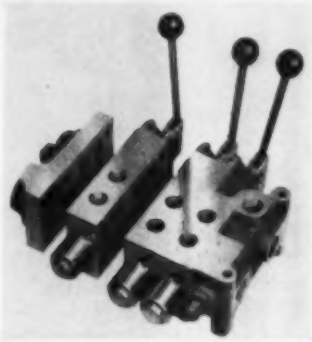
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

RAYBESTOS-MANHATTAN, INC., Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings Brake Blocks • Clutch Facings • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

Circle **131** *on Time-Saver Card*

NEW PRODUCTS

an inlet and relief valve plus two spools in single housing. "Add-on" idea gives user flexibility of having from 2-6 sections without losing



economy of initial single housing construction. Has optional 4th position detent float, 3 or 4-way center operation.

Specifications: Capacity is 20 gals.

Webster Electric Co.
Racine, Wis.

Circle **326** *on Time-Saver Card*

USE A TIME-SAVER CARD FOR MORE INFORMATION ON

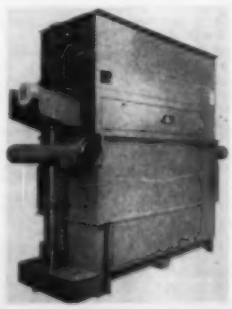
- ADVERTISED PRODUCTS
- NEW COMPONENTS
- USEFUL LITERATURE

AFTERCOOLERS

. . . give increased capacity

Designation: Aero

Features: Increased capacity in more compact equipment because



of improved cooling coil and manifold design. Operation controlled by air by-pass and recirculation

system that varies amount of fresh, out-door air passing through spray chamber. Special trap in manifold removes condensed water.

Specifications: In nine sizes with range of free air capacity from 200-12,000 cfm matching compressor sizes from 40-2500 hp.

Niagara Blower Co.
New York, N. Y.

Circle **327** *on Time-Saver Card*

3-WAY VALVES
. . . are direct operated

Features: Balanced spool type, direct operated. Function as 2- or 3-way valves either NO or NC. Used as selector or directional valves, or in vacuum applications. No modifications required. Used with 4-way valves for dual sched-

ule resistance welding. For single or double solenoid or pilot (air) operation.

Specifications: Sizes from ¼-¾".

Air Valves Co.
Warren, Mich.

Circle **328** *on Time-Saver Card*

MINIATURE FILTER
. . . weighs only 4 oz.

Designation: Model 117-2

Features: For use on small, air-operated instruments, checking gauges, miniature valves. May be attached directly to inport of air device equipment. Cartridge is absorbent, has long life.

Specifications: Measures 2½x1⅛", weighs 4 oz. Has ¼" MPT at one end, ¼" FPT at other. Filters to five microns.

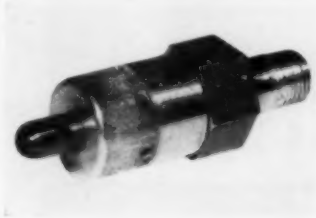
Wilkerson Corporation
Englewood, Colo.

Circle **329** *on Time-Saver Card*

AIR POPPET VALVE
. . . for pilot control

Designation: Pulse-Air

Features: Used to energize pilot



operated air control valves. May be actuated by hand or mechanical means, either direct or remote. Opens and closes only when plunger is compressed, making it unnecessary to decompress plunger before control valve is energized in opposite direction.

Specifications: Size ports are ⅛ and ¼".

Savage Engineering Division
The Lithibar Co.
Holland, Mich.

Circle **330** *on Time-Saver Card*

Capital

HYDRAULIC FILTERS

for Hydraulic and Oil Re-circulating Machinery

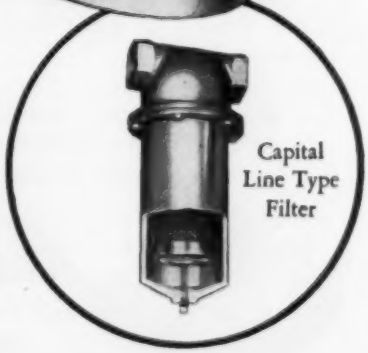
Capital Hydraulic Filter Units are smaller than ordinary filters but with filtering capacity equal or superior to many larger filters. Small size permits greater latitude in design, particularly where space is restricted.

Capital Filter Units are designed with one-piece construction — no screws or nuts to work loose and be lost or mislaid. Simple and easy to clean by any method.

Made from specially designed woven Monel wire, with narrow corrugations presenting the greatest filtering area. Monel support supplies extra sturdiness.

Capital Filter Units are made in 4 Types:

- **MONO-BILT 60 Mesh All Stainless Steel (Sump type).**
- **MONO-BILT Standard All Stainless Steel**
- **MONO-ECONO Mono-Bilt with Monel Metal Insert and Cadmium Plated Top and Bottom.**
- **LINE TYPE with Aluminum Housing and Mono-Bilt, one Piece Filter Unit.**



Capital Line Type Filter

Built from Monel Metal they are impervious to rust and corrosion.

CAPITAL ENGINEERING & MFG. CORP.

5836 SOUTH ASHLAND AVENUE, CHICAGO 36, ILLINOIS

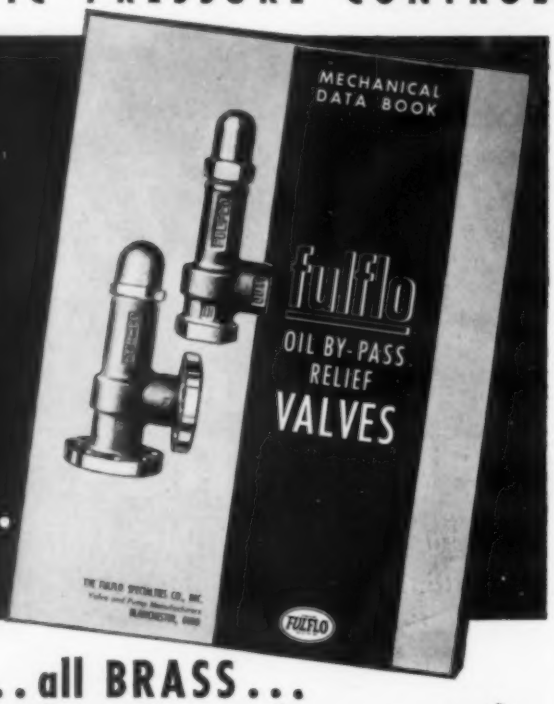
Circle **28** *on Time-Saver Card*

Choose **FULFLO VALVES**

FOR *Positive*

AUTOMATIC PRESSURE CONTROL

FROM THIS NEW DATA BOOK...



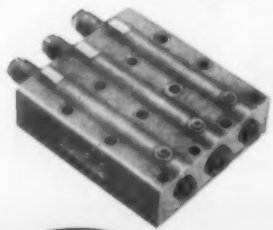
all STEEL... all BRASS...

or combinations to meet your needs

This new catalog and reference to the application of Oil By-Pass Relief Valves simplifies the selection of valves for a wide range of services. Included are flow charts for valves and pipes, dimensions, specifications and other data. Write for your copy today.

FULFLO Valves with shear-closing action assure quiet, safe and dependable operation. Whether for O.E.M. use or replacement, they give superior service at reasonable cost.

- **Screw or flange models . . . to 500 lbs. . . . for pipe sizes to 3"**
- **Steel, cast or brass bodies . . . brass, steel or stainless trim**
- **Fast shipment of standards . . . specials to your requirements**



Need **A "SPECIAL"?**

FULFLO can engineer a special valve to your most exacting requirements. Examples of "specials" are shown in Data Book.

FULFLO **THE FULFLO SPECIALTIES CO., INC.**

415 Fancy Ave. Blanchester, Ohio

Circle **60** *on Time-Saver Card*

USEFUL LITERATURE

Continued from page 78

3-WAY PROTECTOR AIR VALVES

Type PV combine operating and standby safety units in single housing. Provide maximum safety on devices with air clutches and brakes. Complete description of valve operation, power requirements, specifications. Product photos. *The Clark Controller Co., Cleveland, Ohio.*

Circle **419** *on Time-Saver Card*

HIGH PRESSURE PUMPS

For pressure testing, fluid pumping and isostatic pressing. Product photos, cutaway drawings. Specification tables by model number. Performance curves for 15, 30, and 60,000 psi pumps. Application diagrams. Bulletin 158, 12 pages. *Autoclave Engineers, Erie, Pa.*

Circle **420** *on Time-Saver Card*

BELLOWS AND ASSEMBLIES

For all applications. In stainless steel, monel, phosphorus bronze, and beryllium copper. Nomenclature, neck configurations given. Application data, dimension and characteristic tables. Application photos. *Hamilton Division, Bendix Aviation Corp., Hamilton, Ohio.*

Circle **421** *on Time-Saver Card*

TUBE FITTINGS

Prevent vibration fatigue, assure positive seal. Flareless. Cushion unit, a special blend of nylon and fiber-glass, is factory assembled. Product illustrated by parts with full explanation. Size tables, diagrams, ordering instructions given. Hydrostatic pressure test results shown. *Chicago Forging & Mfg. Co., Chicago.*

Circle **422** *on Time-Saver Card*

FLOW CONTROL VALVE

With colored graduations to help adjust, reset valve quickly. Full turn of screw exposes another color. Cutaway drawings, label

drawing with dimension chart. Ordering instructions, application use. Catalog M-101, 2 page. *The Manatrol Corp., Cleveland, Ohio.*

Circle **423** on Time-Saver Card

RUBBER FACT BOOK

Includes installation and compound data. Expanded. Gives size numbers, dimensions of all common O-rings and Quad rings. Sizes cross-indexed for comparison with dimensional specifications. Final section describes Kapseal, with size charts and installation guides. Many cross-section labelled drawings. *Minnesota Rubber Co., Minneapolis.*

Circle **424** on Time-Saver Card

REPRINTS
revised JIC HYDRAULIC STANDARDS

are available at these prices:

Single copy	**75¢**
10 to 24 copies	**60¢**
25 to 49 copies	**50¢**
50 or more copies	**40¢**

Send your order to APPLIED HYDRAULICS & PNEUMATICS Magazine, 812 Huron Road, Cleveland 15, Ohio.

HYDRAULIC FLUID

Designed to meet exacting requirements of modern hydraulic mine machinery. A water-in-oil emulsion in which oil is the continuous phase. Fire-resistant. Minesafe Fluid described in Technical Bulletin 56. Composition, properties, test results, service performance, and typical data given. *Sun Oil Co., Philadelphia.*

Circle **425** on Time-Saver Card

SOCKET SCREW

Has large-diameter-head cap. This Unbrako cap permits up to a 233% increase in screw holding power. Designation is "1960 series." Tabulation of seating torques, dimensions and application data, chart of bearing are for various sizes, and bar graph of load-carrying capacity included in 4-page bulletin. Comparisons made with old 1936 series model. Product photos. *Standard Pressed Steel Co., Jenkintown, Pa.*

Circle **426** on Time-Saver Card

Pathon Series WAL...WHL

AIR AND LOW PRESSURE HYDRAULIC

Cylinders

You can improve the durability and appearance of your equipment with the new Pathon W Series Air and Low Pressure Hydraulic Cylinders.

Valuable space can be saved with these proven screw thread head units. They are available in all standard mounting types plus the type 8, intermediate flange mount (illustrated above) in bore sizes from 1⅛" thru 6".

Specify WAL for air or WHL for oil service to 200 psi. These economical units incorporate non ferrous barrels, hard chrome plated rods, and "U" cup rod packing for minimum friction.

Specify WAT for air service to 250 psi; or WHT for oil service from 350 to 500 psi, depending on bore size. These units incorporate hard chrome plated steel barrels, case hardened, chrome plated rods, and multi-lip rod packing.

All Pathon cylinders have externally replaceable rod packing.

Write for Bulletin #25

Pathon MANUFACTURING COMPANY

A-59 3823 PACIFIC AVE. • CINCINNATI 12, OHIO

FLUID OPERATED AND CONTROL EQUIPMENT

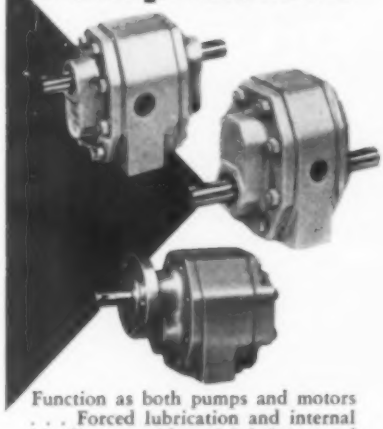
Circle **123** on Time-Saver Card

Offered you...

...by the world's largest builders of hydraulic jacks

PRECISION-ENGINEERED PRECISION-MACHINED INDUSTRIAL HYDRAULIC EQUIPMENT

Pump-Motors



Function as both pumps and motors . . . Forced lubrication and internal bleeding provide axial balance and eliminate high pressures against oil seals . . . Rotation in either direction . . . Heavy-duty roller bearings . . . Small cube space . . . 8, 17, 25 GPM at 1000 PSI . . . Gear type, constant displacement.

Control Valves

Large oil passages . . . Close grained, high tensile alloy body castings . . . 2 types of action . . . Spring centered, ball detent hold . . . Hardened ground spool . . . Precision honed valve body . . . Pressure relief valve . . . Hardened seat insert for long life.

Engineering ingenuity in designing and manufacturing hydraulic systems and assemblies to your own exacting specifications.

5008

Hein-Werner Corporation

Please write to
HEIN-WERNER CORPORATION
Waukesha 4, Wisconsin

Circle **71** on Time-Saver Card

POST SCRIPTS OF INDUSTRY

News about people, manufacturers and sales organizations

N. C. Hunt becomes president, board chairman

N. C. Hunt has taken over as president and chairman of the board at Hunt Valve Co., Salem, Ohio. He founded the company in 1919. Lester A. Bateman, formerly assistant to

N. C. Hunt

Bateman

the president, was named executive v. pres. He joined Hunt this year from Eljer Co. Howard E. Jesko, previously assistant treasurer, has been promoted to v. pres. and treasurer. He came in 1956 as chief accountant. Andrew V. Ney was promoted to sales manager. Arriving in 1957 as a sales engineer, he had been assistant sales manager.

Vickers announces four changes

Vickers Incorporated, Detroit, has named two district managers and appointed a pair of application engineers. Dane Smith, formerly application engineer in the Houston office, is the new district manager at St. Louis. He joined Vickers in 1953 after working one year for Minneapolis-Honeywell Regulator Co. Chester Lenik, who has spent four years as an application engineer in the Minneapolis office, is now district manager in Tulsa. He joined the company eight years ago. Ray Warell, formerly sales coordinator in Detroit, has been appointed application engineer for mobile equipment in the Springfield, N.J. office. He joined Vickers in 1957 after graduation from Wayne State University. A new application engineer in the Minneapolis office is Robert Borden, formerly with the Chicago office.

General Filters expansion is fourth since 1945

A new wing has been added to the General Filters, Inc., plant in Novi, Mich. Extra room will gain manufacturing, storage, and shipping space. It stretches across three-fourths of the rear of the main building, upping available space by one third. This is the fourth expansion for the company since 1945.

Continued on page 176

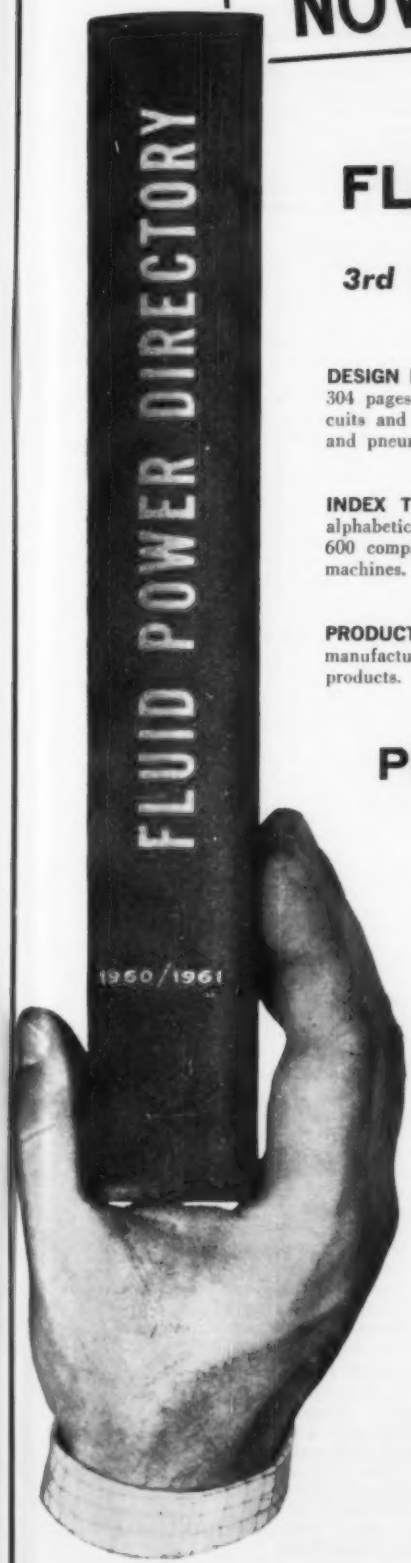
A NEW PLANT for Tomkins-Johnson Co. is now in use in Jackson, Mich. The structure, engineered to meet increased production needs, offers new manufacturing and office facilities. It is located at 2425 W. Michigan Ave.

NOW IN PREPARATION

The complete guide to FLUID POWER APPLICATIONS

3rd Edition—

the only complete hydraulic and pneumatic reference



DESIGN DATA AND IDEAS—Section A gives you 304 pages of standards, nomographs, formulae, circuits and product designs. Complete JIC hydraulic and pneumatic standards.

INDEX TO MANUFACTURERS—Section B lists alphabetically names and addresses of more than 600 companies making products for fluid powered machines.

PRODUCTS DIRECTORY—Section C helps locate manufacturers of hydraulic, pneumatic and electrical products. Listings of advertisers appear in bold face along with the note "See Section E pages — to —."

TRADE NAMES—Section D tells you who makes a product when you only know its trade name. Bold asterisk points out advertisers in the Directory.

SPECIFICATIONS—Section E gives you manufacturers' catalog information on their products. Advertisements are arranged alphatbetically, within limitations of binding and printing. Index pages give information on sales offices and distributors for each advertiser.

LOCAL SOURCES—Section F (Yellow Pages) lists alphatbetically by state, city and company, all local sources for fluid power components.

PUBLICATION DATE: OCTOBER 29, 1959

Compiled and Published by

Applied **Hydraulics & Pneumatics**

The Magazine of Fluid Power

812 Huron Road Cleveland 15, Ohio

You can reserve a copy now.

$10.00

FLUID POWER DIRECTORY
812 Huron Road, Cleveland 15, Ohio

Please reserve .... copy(ies) of the 1960/61 edition priced at $10.00 a copy.

☐ Check enclosed ☐ Bill me

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IF IT ROTATES SEALOL CAN SEAL IT

for transferring

GASES-VAPORS
LIQUIDS
CRYOGENICS

TO 50 RPM

Pressures to 3,500 PSI
Temperatures to 350°F.

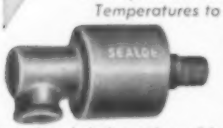
TYPE C SWIVEL JOINT

Precision-engineered and built for applications calling for low RPM's or oscillating motions. Special aircraft types meet or exceed Spec. MIL J-5513.

Current applications include atomic submarines, jet aircraft, coal mining and railroad track maintenance equipment.

TO 1,200 RPM

Steam pressures to 150 PSI
Fluid pressures to 350 PSI
Temperatures to 425°F.



TYPE L ROTARY JOINT

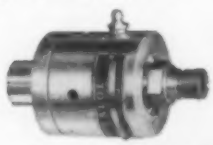
Balanced seal design reduces friction to the absolute minimum for low torque giving long, trouble-free life. Available with or without syphon pipe.

Current applications include textile, paper, plastic, and rubber plants.

TO 10,000 RPM

Pressures to 1,000 PSI
Temperatures to 150°F.

TYPE EL FLUID TRANSFER



New, high performance unit for transferring coolants and other fluids through a rotating, hollow spindle or shaft. Built to withstand rapid cycling pressures to 1,000 PSI such as those found in hydraulic and pneumatic chucks.

Current applications include deep hole and precision drilling conversions, turret lathes and chuckers.

SEALOL CORP.

159 Post Road, Providence 5, R. I.

Circle **140** *on Time-Saver Card*

POST SCRIPTS OF INDUSTRY

Parker Seal appoints distributors

Parker Seal Co., Culver City, Calif., a division of Parker-Hannifin Corp., has made four distributor appointments. They are Carpenter Bearing Co., Odessa, Texas, for O-rings; Al Xander Co., Corry, Pa., for O-seals; Roger Zatkoff Co., Detroit, for O-rings and O-seals, and Jay Berwanger, Inc., Chicago, for O-rings.

Eastman selects Anhalt for sales mgr.

Anhalt

J. A. Anhalt has been chosen sales mgr. of Eastman Mfg. Co., Manitowoc, Wis. With the company 18 years, he has been supervisor of the controls department for 12 years. He succeeds W. D. Dalrymple, who has held the post since 1947.

Superior Tube adds to main plant

Superior Tube Co. has completed construction of a new office building and factory addition to its general office and main plant at Norristown, Pa. Total cost of expansion is estimated at $2 million. Added are an ultra-modern two-story office building and one-story addition to the mill. Existing space has been doubled.

Weatherhead Division has new general sales mgr.

Wade

A. S. Wade has been named general sales mgr. of Weatherhead Co.'s Fort Wayne Division. He joined the company in 1929 and has served as production manager, Detroit district mgr., automotive sales mgr., and general sales mgr. of the original equipment division.

ADAMS FACT FILE #3

INSTRUMENT AIR

Clean Dry Air Supply Will Reduce Production Down-Time . . . Instrument Maintenance . . .

Wet, dirty compressed air has no place in the process industries. In instrument air supply lines it can cause havoc. Whether it be motor air in a control circuit or supply air to the control panel, absolutely clean dry air is vital. Moisture elimination is the major consideration in providing suitable air for instrument and control systems.

Since most plant compressors in use today are oil lubricated, a finite amount of oil is present with the water vapor in the discharge. This carry-over condenses as an oil-water emulsion which often causes serious fouling of instrument components. To eliminate this oil-moisture condensate in the air lines, it is necessary to remove it before it reaches the distribution system. This is done by cooling the air before the receiver. It is advisable to cool well below the ambient conditions to provide the lowest possible humidity at the instrument panel or control units.

Two Stage System Design for Economy

The ideal method to achieve high quality air is a two-step operation.

1—An Adams Aftercooler . . . providing 2° F. cooling . . . and Cyclone Separator installed between the compressor and receiver to remove the bulk of moisture carry-over.

2 — A chemical dryer installed down stream to provide the polishing action necessary for the desired minimum humidity.

Thus, the bulk of water . . . 90% . . . is removed by the Aftercooler-Separator using plant water for cooling. A minimum moisture load is then left to be removed by more expensive methods. Under normal circumstances, all of the oil present in the compressor discharge will be removed in the Aftercooler-Separator. Fouling of the chemical unit is then virtually eliminated.

Poro-Stone Air Filter at Panel Provides Dirt-Free Control Air . . .

In spite of the efficiency of the Adams Aftercooler and Separator, there still will be some dust and dirt present in the instrument air system. That's why it is advisable to install an Adams Poro-Stone Air Filter in the line just before the control panel.

Separation by the Adams unit is in two stages — centrifugal and diffusion. Centrifugal force throws the foreign matter to the walls of the filter body where it is trapped in slots and drained. Remaining particulate matter is removed as the air passes through the pores of the Poro-Stone element.

This final protection for your instruments will minimize control system failures and process down-time. Instrument maintenance will be sharply reduced.

Literature Will Help Air System Design

For further information on how the complete line of Adams air equipment can help you provide a foolproof instrument air supply, write today for your copy of Bulletin No. 712 on Aftercoolers and Separators and Bulletin No. 117 on Poro-Stone Air Filters to the R. P. Adams Company, Inc., 249 East Park Drive, Buffalo 17, New York.

Circle **2** *on Time-Saver Card*

Wilkerson names two distributors

Two new distributors were named by Wilkerson Corp., Englewood, Colo. Machinery & Machine Supplies Co., Inc., New York, is the zone managing distributor in that area. For Alabama, distributors will be Dixie Industrial Equipment Co., Inc., Birmingham.

Joyce is sales engineer

New sales engineer in the Detroit office of National Seal Division, Federal-Mogul-Bower Bearings, Inc., is Robert E. Joyce. Formerly with Minnesota Mining & Mfg. Co. he will service original equipment accounts in southern Michigan.

Duffin appointed manager

Edward A. Duffin has been appointed district sales mgr. for Barksdale control valve and pressure switch divisions in the New York City area. Charles McClain, who previously covered part of this area, has been named district sales mgr. for Northern New Jersey.

Dynex promotes Graas

James H. Graas has been named manager of strategic sales for Dynex, Inc., Pewaukee, Wis.

Barnum chosen district sales mgr.

Barnum

Robert Barnum has been promoted to be Los Angeles district sales mgr. for Flexonics Corp., Maywood, Ill. He joined the company last year as sales engineer after working with Haskell Engineering Associates and Lockheed Aircraft.

Doty is new sales promotion manager

Lawrence R. Doty has been named industrial sales promotion manager for A. Schrader's Son, New York. For the past four years, he has been the Southeastern sales representative.

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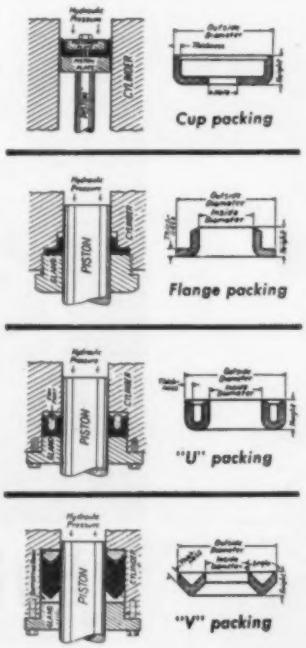
Page...

a dependable source for mechanical packings



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The Fall "CJ"* Wiper-Scraper Ring is Spring-Loaded causing Squeeze-Grip Action on the O.D. of the piston rod during entire cycle. This patented feature maintains a uniform, continuous pressure on the wiping edge of the ring at all times, stopping any buildup of foreign matter between the ring and the rod.

It automatically takes up wear, maintaining NEW RING PERFORMANCE. Available in diameters ½" through 13" for any commercial use. AN and MS numbers in use by the Military and Aviation industry since 1944. Manufactured in accordance with MIL-S-5049. (*Closed Joint)

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Est. 1935

POST SCRIPTS OF INDUSTRY

Vaters is new representative

Appointment of Nicholas Vaters as sales engineering representative for the New England area was announced by the newly-organized industrial sales division of Cleveland Pneumatics Industries, Inc., Skokie, Ill. The new division offers a broad line of air-motion conversion components.

Tuttle new field representative

Charles H. Tuttle, Jr., is a field representative for Allen Manufacturing Co. in the Chicago territory. He joined the company in September as a sales trainee.

Beckert is district manager

New district manager for Parker-Hannifin Corp. in the Cincinnati area will be Richard A. Beckert. His territory for distributor sales is Southern Ohio, Kentucky, and Indiana. Beckert, sales engineer with Crouse-Hinds Co. and Timken Roller Bearing Co., was recently with Banker's Life of Iowa.

Moorehead joins Parker Seal

New sales representative in the Philadelphia district for Parker Seal Co., Culver City, Calif., is Harold Moorehead, Jr. He joined the company from Dural Rubber Co., Flemington, N. J. and is a Drexel Institute graduate. Moorehead's territory will be Eastern Pennsylvania, Southern New Jersey, Delaware, Maryland, Virginia, and West Virginia.

Springer named technical director

New technical director for Knox, Inc., in Connecticut, is Russell F. Springer. He will be responsible for technical liaison work with customers on applications, and technical training of field representatives. Springer was a design engineer at Glenn L. Martin Co. and an instructor at VPI.

OPW-JORDAN *pressure reducing* **VALVE***

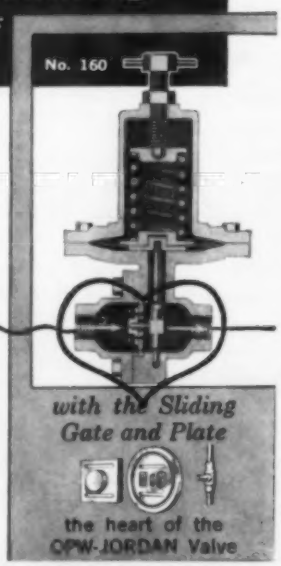
- DEAD END SHUT-OFF
- WIRE DRAWING MINIMIZED OR ELIMINATED
- SELF-LAPPING SEAT
- NO HUNTING . . . SHORT STROKE FOR IMMEDIATE RESPONSE

THE DIFFERENT AND IMPROVED WAY TO CONTROL PRESSURE.

The unique basic design and exclusive features of this valve are responsible for its outstanding performance and long dependable service life—its precise regulation with immediate response and unusual sensitivity.

*Daily replacing troublesome pilot operated valves.

For more facts, write for Bulletin J-160.



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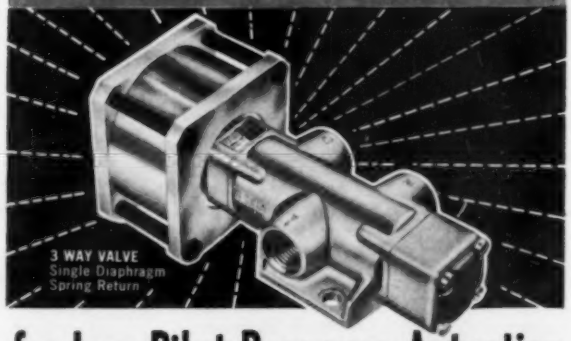

for Low Pilot Pressure Actuation

■ Versa Diaphragm Valves can be actuated by pilot (or signal) pressures as low as 5 PSI on double diaphragm types and as low as 10 PSI on standard spring return models.

Versa Diaphragm Valves are available with side port bodies or for manifold mounting, and in sizes from 1/8" thru 1" NPT in 2-, 3-, 4-, and 5-way types, and for pressures from partial vacuum to 500 PSIG.

All Versa Valves are triple pressure and functionally tested under water for guaranteed leakproofness.

VERSA

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Wallach new v. pres.

Bernhard Wallach has been named v. pres. for engineering by Marsh Instrument Co., Skokie, Ill. He has been chief engineer for the last 17 years and has devoted 33 years to the design of pressure gauges and similar instruments.

Moore is sales manager for Blackhawk

Moore

Paul F. Moore has been named to fill the newly-created position of sales manager of the industrial division, Blackhawk Mfg. Co., Milwaukee. He came to the company in 1956 and has served in distributor sales and industrial marketing.

Two join Houghton field staff

William Cochran and John Volk have been added to the field engineering service staff by E. F. Houghton & Co., Philadelphia. Cochran will cover New Jersey, while Volk handles the Cleveland division office.

Munger new field salesman

Munger

James H. Munger has been added to the field sales force by International Packings Corp., Bristol, N. H. He was formerly associated with Garlock Packing Co. Munger will be based in Rochester, serving customers in northern and central New York State.

Two vice presidents named for Kahn

Robert Sheldon has been named v. pres.-engineering for Kahn & Co., Inc., Hartford, Conn. Robert Hamerschlag was appointed v. pres.-sales. Sheldon joined the company as chief engineer in 1955 and, in his new position, will be responsible for the design of all test equipment and standard products. He also will be in charge of the product development program. Hamerschlag joined Kahn as sales manager in 1955.

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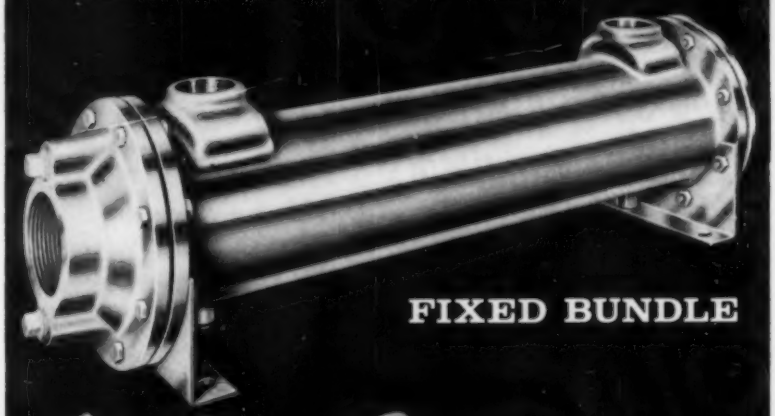

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FEATURING:

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FOR:

- Auxiliary power
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THREE MOST POPULAR SIZES:

One quart, one-half gallon and one gallon, 13", 18⅛" and 28½" long, respectively. All 4¼" diameter. (Larger sizes: 2½, 5, 10 gallons; all 8⅝" diameter.)

Standard temperature range:—40° to +220° F. Seals also available for fuels and special fluids as well as for temperatures from —65° to 400° F.

For more information about these new Narda Accumulators, as well as other models now in development, write to us at Dept. AHP-2.

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Subsidiary of The Narda Microwave Corp.

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POST SCRIPTS OF INDUSTRY

Harmon is sales manager

New sales manager for Airmatic Valve, Inc., Cleveland, is George Harmon. He is a veteran of 13 years in sales.

Republic Mfg. opens West Coast office

West Coast headquarters have been established by Republic Mfg. Co., Cleveland. The office, which opened Sept. 1, is located at 18600B Amigo St., Northridge, Calif. Manager will be Carl Drenske, formerly West Coast factory representative. Stewart Cozza is sales engineer, and Alan Pinch, service engineer. A sales engineer, located in San Francisco, is in future plans.

Dudreck named sales promotion mgr.

Albert W. Dudreck has been appointed manager of sales promotion and advertising for Hankison Corp., Canonsburg, Pa. He was formerly advertising manager of the Rome Cable Co., and has spent several years in the advertising agency field as an industrial account executive.

Wheeler is new field sales mgr.

Wheeler

Eugene Wheeler has been appointed field sales manager of the Nopak Division, Galland-Henning Mfg. Co., Milwaukee. Recently he was a commercial sales representative with Cornelius Co. Before that, Wheeler was a salesman with Nopak's Minneapolis representative the John Henry Foster Co.

Vonbee increases staff

Herbert A. Niedhammer has been added to the Vonbee Co., Livingston, N. J., staff. As an associate on industrial sales engineering. Previously he spent 15 years with The DeVilbiss Co. in the Eastern regional area.

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Write today for the latest LENZ catalogs and Literature . . . Ask to be put on our mailing list.

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Collioud is promoted

Appointment was made of T. R. Collioud as manager of automotive and aircraft distributor sales for Bendix Filter Division, Bendix Aviation Corp., Madison Hts., Mich. He has been with Bendix 10 years, holding positions of service sales manager and sales promotion manager.

Zurbrigg is new engineer

Raymond C. Zurbrigg has been named lubrication engineer by E. F. Houghton & Co., Philadelphia. He formerly worked as production manager of the Royal Lubricants Co., Hanover, N. J.

New distributor appointments

Tulsa Gauge & Instrument Co., Tulsa, and Betts-Eastman Ltd., Winnipeg, for Barksdale Valves, Los Angeles. Tulsa will represent the pressure switch division in Oklahoma, while Betts-Eastman will be valve and pressure switch representative for the Manitoba Province.

J. E. Myles, Inc., Detroit, is exclusive distributor for Greer Hydraulics, Inc., in the Michigan-Ontario area.

Air-Draulics Co., Phoenix, has been named the Arizona representative for Bell & Gossett, Morton Grove, Ill.

Rio Grande Sales Co., Albuquerque, is the New Mexico distributor for Wilkerson Corporation's air products.

R. C. Neal Co., Inc., Buffalo, is exclusive distributor in Western New York for Rivett Lathe & Grinder, Inc., Boston.

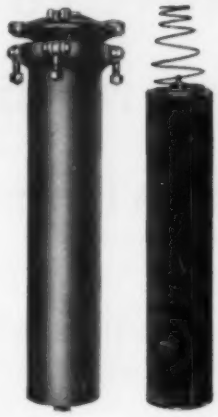
Knox, Inc., East Walpole, Mass., has been named exclusive representative in New England for Rosaen Co. filters.

Krico Engineering, Detroit, is a new distributor in that city for Republic Mfg. Co., Cleveland.

James Engineering & Machinery Co., Dearborn, as Michigan representative for Precision Products, Inc., Cleveland.

R. M. Elicker, Far Hills Station, Dayton, Ohio, as south and west-central Ohio representative for the Industrial Control Division Sterling, Inc., Milwaukee.

NUGENT
FILTERS • STRAINERS
LUBRICATION SPECIALTIES



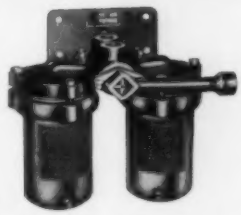


Fig. 1555BF Duplex Filter uses factory packaged laminated fiber disc filtering elements. Each filter comprising duplex operates independently or in parallel. Wide range of sizes.

Fig. 1576 Bag-Type Pressure Filters feature inexpensive, completely disposable filter cartridges. For filtering fuel oil, lubricating oil and wide variety of fluids.

AT LEFT: Fig. 1555-4L Filter and laminated disc cartridge. High flow rate; low pressure drop. Excellent micronic efficiency. Cartridges interchangeable with all other Nugent Bag or Depth Type cartridges.

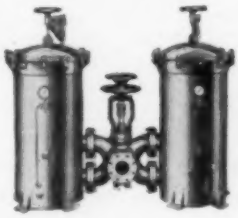


Fig. 1554AN-4L7 Duplex Strainers provide the advantage of uninterrupted flow, without by-passing, while cleaning the strainer baskets. Each strainer comprising duplex uses 7 strainer baskets Fig. 1554A-4L.

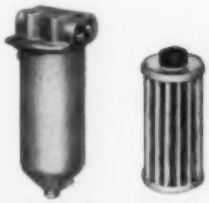


Fig. 1490AM-0 star-shaped extended area strainers offer increased free screen area over round basket type.

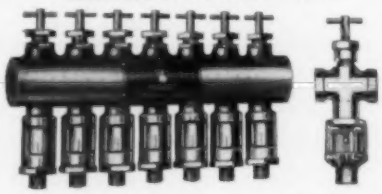


Fig. 1503F Multiple Pressure Oilers are available with from 2 to 24 feeds.

Fig. 524 Sight Feed Valves with removable glass. ¼" to ¾" IPS.

Fig. 1575 Pressure Sight Flow Lubricator. Single units or multiples to 15.

Fig. 1366E Sight Flow Fittings for indicating flow of liquid in a pipe line. Available in brass, cast iron, steel or stainless steel.

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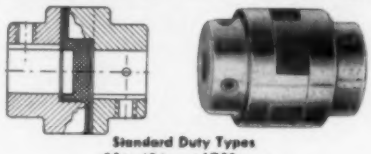

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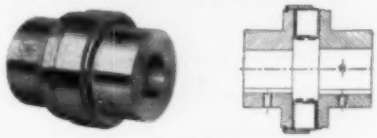

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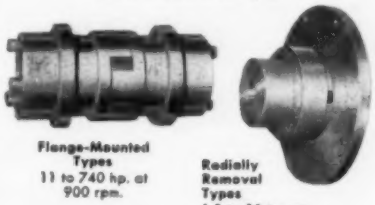

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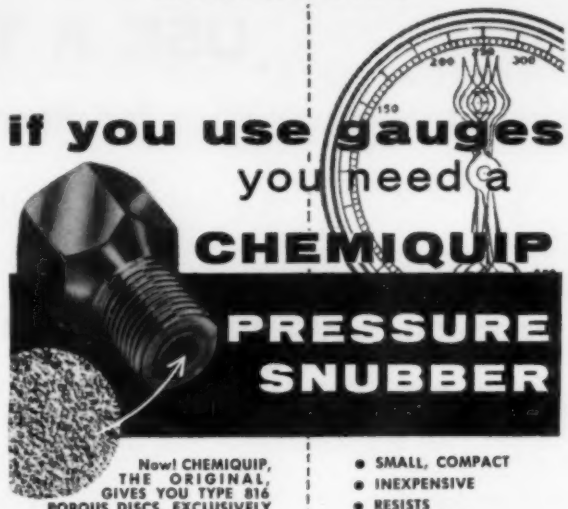

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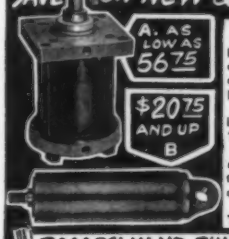

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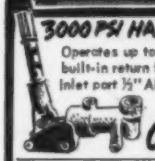

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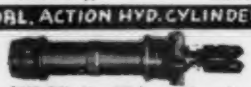

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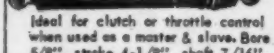

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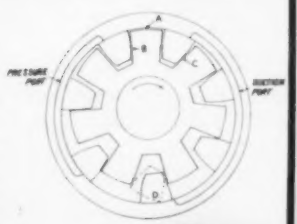

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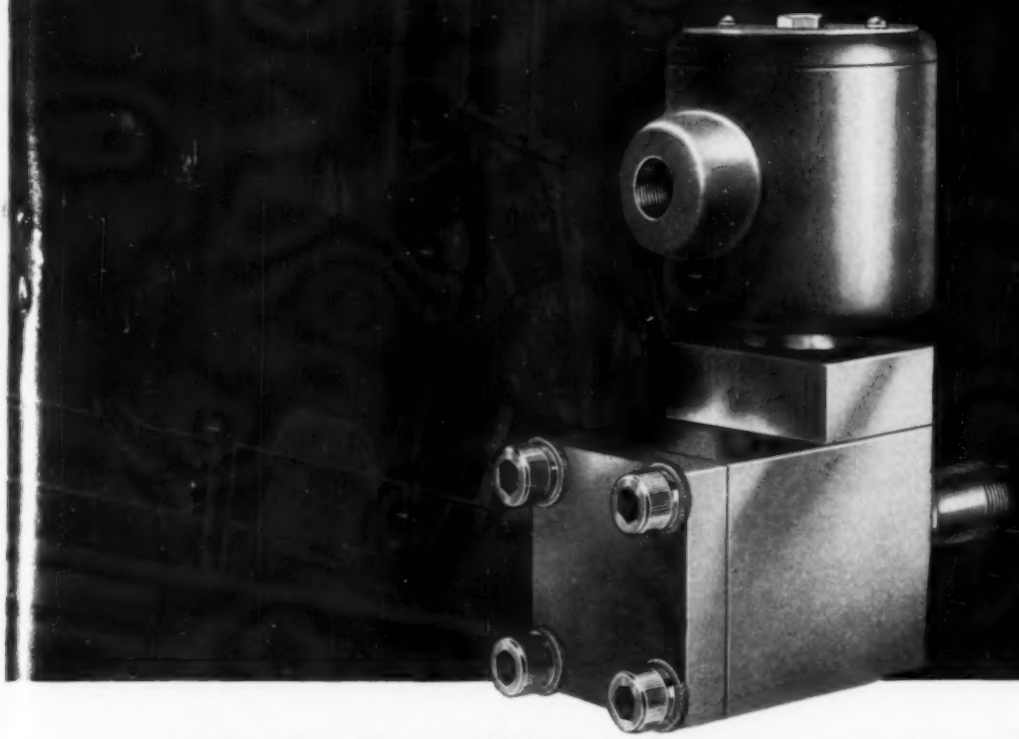

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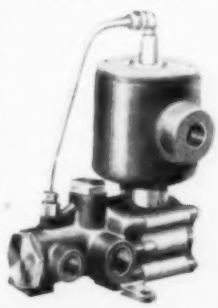

Proposals are submitted upon receipt of specifications—or an ASCO Engineer can help you in solving your ground support valving problems.

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